JOURNAL OF DAIRY SCIENCE

AUGUST, 1956

In this Issue:

The Miracle of the Milk Cow

Proceedings of the 51st Annual Meeting

Student Chapter News

Abstracts of Literature

Eight articles pertaining to research in dairy manufactures

Five articles dealing with dairy production subjects

News items and happenings in industry

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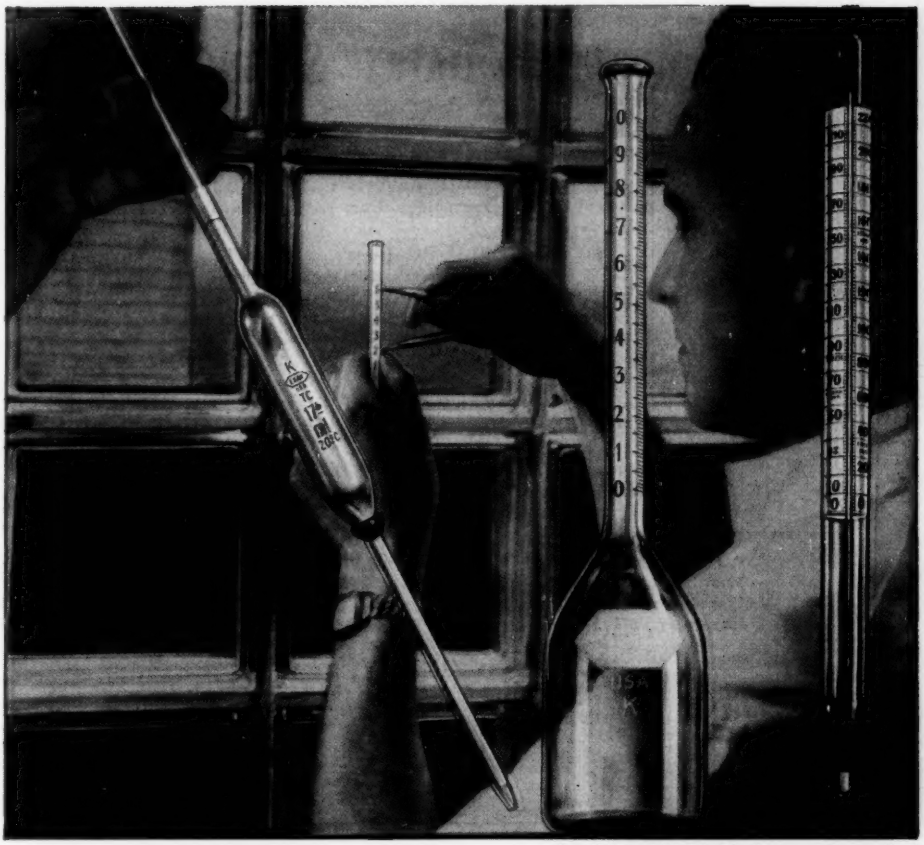

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Manuscripts for publication in the Journal of Dairy Science should be submitted to the editor, P. H. Tracy, at the address above. See January, 1954, issue, page 103, for information concerning the preparation of manuscripts, or send for reprint, "Information for Authors."

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Membership dues in the Association are $10.00 a year and should be sent to the secretary-treasurer at the address above. Renewals should be made not later than December 1 each year.

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PEOPLE and EVENTS
in the Dairy Science World

L. H. Rich Receives Government Award

LYMAN H. RICH, extension dairy specialist at the Utah State Agricultural College, was extended the U. S. Department of Agriculture Extension Service superior service award June 5. The presentation was made by Secretary of Agriculture, EZRA T. BENSON. The ceremonies took place at the base of the Washington Monument. Several distinguished government officials, as well as members of Professor Rich's family, and friends were present for the ceremonies.

L. H. Rich receiving government award from Secretary of Agriculture Benson.

The citation was given for outstanding public service in conceiving the idea, developing field operations, and assisting with procedures for using mechanical means to process massive quantities of dairy production and breeding records, which has resulted in more efficiency and greater economy of operations.

Professor Rich, a veteran of World War I, received his B.S. degree from the Utah State Agr. College in 1925 and his M.S. degree from the Univ. of Minnesota in 1930. Until 1936 he was county extension agent in Utah. Since that date he has served as state extension dairyman of Utah. In 1949 he attended the World's Dairy Congress in Sweden. He has recently completed a 3-year term as a director of A.D.S.A.

University of Kentucky to Modernize Dairy Plant

Complete modernization of the Dairy Products Plant of the Dairy Section of the University of Kentucky will be made this fall, according to T. R. FREEMAN, professor in charge of dairy manufacturing. The modernization plans call for an extensive rearrangement of plant layout and for almost complete renewal of processing equipment. The plans also include the acquisition of equipment that has not been available heretofore in Kentucky for research and training purposes. Included in this category are a vacuum pan and spray drier. While building alterations will be held at a minimum, a major improvement will be made by the laying of non-skid tile floors throughout the processing plant.

Revisions in the market milk section will include equipment for HTST pasteurization, homogenization, and vacuum treatment of milk; installation of a Pure-Pak machine and a machine for the canning of milk for bulk dispenser use. After this revision is made, many of the food service units of the University will be able to serve milk from dispenser units rather than in the bottle. This change was planned after considerable study by staffs of the food service units and the Dairy Section.

The new fluid milk section will be so designed that it can be handled by one man. Cleaning of most of the equipment will be by the clean-in-place method. Inclusion of a vacuum treatment apparatus will place the plant in the forefront of industry and will enable the Dairy Section to do considerable training and research with this method of treating milk. In the ice cream section plans are being made to expand and improve refrigeration, obtain an additional freezer, a fruit feeder, and increase mix storage facilities. The resulting semi-commercial ice cream–making operation will greatly enhance physical facilities for research and teaching in this field. The plans also include modernization of butter manufacturing facilities.

New to the University Dairy Section will be a concentrate milk section. Included will be a moderate-size vacuum pan and a small spray drier. There will also be facilities for storage of milk and for preheat treatment. The spray drier will be one of the first five to be installed in the state.

USDA Announces New Dairy Record-Keeping Plan

Giving farmers a better chance to make their dairy operations more efficient and profitable is the main idea behind a simple new low-cost plan for keeping dairy production records.

The plan has been approved by the American Dairy Science Assoc. and the Extension Com-

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mittee on Organization and Policy. This new "Weigh-a-Day-a-Month" program is expected to go into operation this fall as an addition to present national federal-state cooperative D.H.I.A. production recording programs. It will be supervised by state extension services under the local direction of county agents.

USDA and state dairy officials see in this new plan an opportunity for dairymen not only to improve production efficiency but, through culling of low-producing cows, possibly to prevent some excess milk from reaching markets. In order to cull their herds intelligently, dairymen must have accurate production information to guide them.

The new plan is somewhat similar to a low-cost record keeping program operated in Illinois for the past 2 years. Variations of the plan have also been operating in a number of other states. Its sponsors hope that it eventually will place an additional 8 to 10 million cows under milk recording.

The new method simplifies milk recording to the single practice of weighing the milk output of each cow in a herd, morning and night, one day a month. The farmer weighs the milk himself. No milk samples or butterfat tests are required. He records the weights on a special form, which he mails to a central computing office. His only cost, averaging about 50 cents per cow per year, is for the calculation of the monthly milk production, the total production to date for each cow, and the yearly herd total to date. If feed information is reported, calculations will also be made on value of product, total cost of feed, and income over feed cost for the herd. A yearly herd summary will also be calculated, and the records are returned to the farmer each month for his use in culling low-producing cows, feeding each cow according to her production, and selecting the best animals from which to raise herd replacements.

Babson Publishes New Booklet

For getting ahead in the dairy business these days there's no greater secret of success than greater output per man-hour of labor. To help dairymen cut their labor and increase their production, Babson Bros. Co. have published a 14-page booklet, complete with illustrations. It's entitled "Let's Get the Cows Up Off the Floor." Free copies may be obtained from Babson Bros. Co., 2843 West 19th Street, Chicago 23, Illinois.

The 1958 ACHEMA Congress to Include Nuclear Physics and Technology

The 12th Chemical Apparatus and Equipment Congress and Exhibition will take place in Frankfurt am Main during the period May 31 to June 8, 1958. For the first time in the history of the ACHEMA Congresses and Exhibitions will Nuclear Physics and Technology form a separate group in the Exhibition. ACHEMA Congresses and Exhibitions are recognized the world over as the meeting place of manufacturers and designers of chemical apparatus and equipment.

Some 10,000 specialists and experts are expected as visitors in 1958, and, in order to facilitate their activities during this period, the Exhibition has been broken down into the following groups:

Nuclear Physics and Technology
Laboratory Technology
Measurement and Control Technology
Operational Technique
Pumps and Fittings
Materials
Chemical Technology
Research and Literature

The ACHEMA Year Book 1956/1958—the European Catalogue of Chemical Apparatus and Equipment—will appear in four languages (English, French, German, and Spanish). It is intended that this book shall serve as an introduction and preparation for attendance at the Congress.

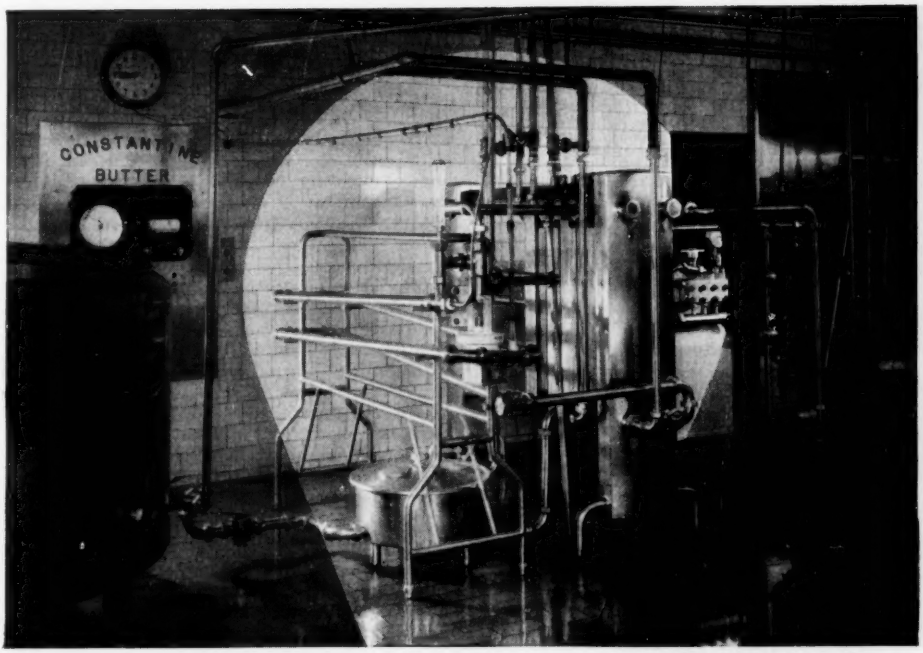
Recent Deaths

DEAN JORDAN G. LEE, JR., 70, scheduled to retire June 30 after 25 years as head of the College of Agriculture at Louisiana State Univ., died on June 28 after an illness of several months. He would have retired with the title "Dean Emeritus."

Although not a specialist in the dairy field, he inaugurated dairy experimental work in Louisiana in 1908. In cooperation with a representative from USDA, feeding trials with calves and dairy cows were conducted and individual cow records were secured from a number of herds. He was also instrumental in the first purchase of dairy cattle for LSU.

In 1909 Dean Lee went to Southwestern Louisiana Institute to head the agricultural department. He returned to the University in 1919 to teach vocational agriculture and in 1931 was appointed dean of the College of Agriculture.

C. E. COTTON, milk and food sanitarian for the state of Idaho, passed away at his home in Boise, June 23, as a result of cancer. A native of Idaho, Mr. Cotton graduated from the State University in 1941 and obtained his M.S. degree at the Univ. of Minnesota in 1951 in public health. He was a veteran of World War II and held a reserve commission in the U. S. Public Health Service. He is survived by his wife and three children.



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Massachusetts to Hold Seminar

The Univ. of Massachusetts will hold a Dairy Farmers Seminar, January 23-24, 1957, at Amherst. Details of the meeting will be announced later.

Request for 1923 Journals

C. C. WALTS, manager of research for H. P. Hood & Sons, 56 Roland St., Boston, wishes to obtain copies of the *Journal of Dairy Science* for January, May, July, and November, 1923. The printer has none of these in stock. Anyone who can supply these issues will please contact Mr. Walts.

Completed Theses

M.S. Degree:

WALTER S. CEGLOWSKI—A study of a modified starch product as an ice cream stabilizer. Rutgers Univ.

Ph.D. Degree:

G. K. MURTHY—A comparison of some of the chemical and physical properties of the gamma casein and immune globulins of milk. Univ. of Illinois.

Guest Editorial

Press of personal matters has long delayed replying to your request for a Guest Editorial. I have hesitated a little in making suggestions for I am quite mindful of the suggestion someone has made that "to live happily and at peace with his associates a retired professor should tread carefully and speak softly." However, a past editor possibly may be permitted a few observations regarding the problems of the Journal, which of course has always been close to my heart. I have just looked over the Golden Jubilee issue and I am very sure that it is a wonderful summing up of 50 years of progress in the dairy industry, and I wish to take this opportunity of complimenting the editor and his associates for their wisdom and their work in planning and so fittingly completing the hundreds of details that have to be looked after in an issue of this kind.

J. H. Frandsen

This issue and the regular monthly issues are the Association's best tool and morale builder and should have the hearty support of all teachers of dairy subjects and scientific and technical workers in the dairy industry. There has always been some criticism of dairy editors concerning their style and language, but readers of the Journal should be charitable, bearing in mind that the editor has to adopt that particular style and language best suited to convey the details and essentials of his scientific contributors. Obviously he can't be all things to all persons nor can he be a scientific journal editor and at the same time a popular trade paper editor. Therefore, it would seem that except for brief, special paragraphs, or boxed-in items calling attention to the contents of certain articles and their possible practical application to a certain group of workers, he should be allowed to stick fairly close to his own scientific method of handling Journal articles, beamed particularly to members of the Association. Trade paper and general news editors should be able to make their own application for their respective class of readers. In short, I would suggest that your editor be given freedom to adopt the style and the language that to him will best convey the scientific ideas submitted in the papers to the Journal.

I would also like to suggest to you contributors of papers to the Journal that you can greatly help your editor by carefully thinking out what you wish to say. Don't be in a hurry to rush into print; be sure that your work has been well planned, that your results are positive, and not until then are you ready to put it on paper in specific language. And don't hedge or qualify so much that your conclusions are more or less meaningless. As an example of what I mean I have heard workers say, "Yes, but I want to qualify my article so that no one can criticize any part of it," which in my opinion often means that he has not made much of a contribution except possibly to embarrass the editor who would like to reject his paper. I have wondered whether the vast sums spent in dairy research in our various dairy institutions, with possibly a few exceptions, have brought results comparable to those achieved with similar resources by commercial interests or private foundations. If I am wrong, the statement will at least be thought-provoking and a challenge to dairy workers in our dairy institutions.

The Dairy Science Association, the administrators of dairy research programs and, the editor of the Journal, all in my judgment, should work hand in hand for more and better research, for research reports and papers that are written in good English and with definite and pointed conclusions—conclusions that are meaningful and definitely add to our accumulated knowledge.

J. H. FRANDSEN

Emeritus Head
Department of Dairy Industry
University of Massachusetts

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STUDENT CHAPTER NEWS

A section devoted to the activities of dairy students

E. L. THOMAS, *Editor*

Leadership Training—Is Major Goal of A.D.S.A. Student Program[1]

W. L. SLATTER

Chairman, Student Affiliate Committee, A.D.S.A.

Industry is now conducting one of the greatest manhunts in history for prospective leaders in different fields. The favorite hunting ground is on the campuses of the many colleges and universities. It is sometimes said that from 3 to 5% of all college students may be considered leaders. During their college training period, this group frequently choose experiences that make them better leaders, but the vast majority of students graduate without a knowledge of what leadership is and have no idea of how it can be developed.

The development of leadership is the major goal of the American Dairy Science Assoc. student affiliate program. A leader may be defined as an individual who can get things done through others. The more people an individual can work through, the greater is his capacity as a leader. The ability involves many things but, in general, is associated with the following characteristics.

The first is a talent for working effectively with others. This involves an individual's ability to present his ideas, to influence, "sell," persuade, and to secure the confidence and respect of other people. This important capacity depends on one's interest in, and understanding of, people and the ability to see the other fellow's point of view. It includes persuasiveness, tact, diplomacy, finesse, enthusiasm, self-confidence, impressiveness, sense of humor, and perspective, according to the needs of the particular job. Skill in writing and speaking effectively is very important in this area.

The second characteristic is the ability to organize activities so that each individual can function most effectively. This involves building a first-class team of good men, well trained and well placed; looking ahead to size up a situation, crystallize objectives, formulate sound constructive policies and programs, and plan and schedule performance so that objectives will be achieved easily and harmoniously.

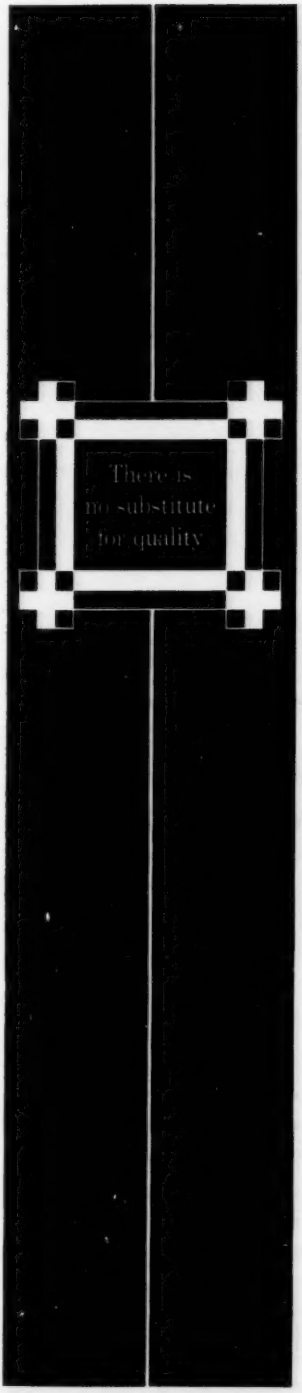
The third characteristic is the ability to recognize, think through, and work out sound solutions to problems. A man's value in this direction involves his keenness and intelligence; his analytical capacity; his ability to develop a conclusive case; his soundness, balance, objectivity, imagination, originality; breadth of vision and comprehension; and his intellectual honesty and courage.

The fourth essential quality involves a man's professional competence; his authoritative knowledge within a specific field. This ability rests upon an individual's natural aptitude, his academic training, his practical experience and his zeal for continuing to widen his horizons to keep himself up-to-date. Of these areas in the development of leadership, only the fourth is covered in formal academic courses; the others must be developed outside the classroom. The most logical place to develop these abilities is in student activities. It has already been indicated that the ability to associate harmoniously with other people is fundamental to the development of leadership. There is no better place to develop the "art" of human relations than in activities. Since the ability to write and speak is important, every member can be given an opportunity to develop these talents. Writing committee reports and articles for news letters or yearbooks, preparing minutes, and answering correspondence are all ordinary projects that can aid in this objective. Activities present an excellent opportunity to develop speaking ability by giving the individual an opportunity to present his ideas; to "sell" and persuade others in such a way that he gains their support for his ideas. The membership can gain much valuable experience in speaking by giving reports of various kinds or taking part in panel discussions on formal programs.

Activities present an excellent opportunity for an individual to reach objectives through others because the normal functions of such organizations are usually performed through the action of committees. The first real opportunity to develop this ability comes when he is appointed to be a committee chairman. The chance to form a first-class committee, well placed and informed, to reach an objective or perform a function followed by a well-written report is an opportunity that should not be ignored. The committee chairman must size up the situation, crystallize objectives, formulate programs, plan and schedule performances that reach the desired objectives.

It is in activities that a student soon learns about the importance of good organization, for if it is lacking, nothing is accomplished. He has an opportunity to learn good business practices such as budgeting and meeting a budget. The experience to be gained in the promotion of social functions and special projects through newspapers, journals, news letters, posters, and other means is an experience that should be

[1] Reprints of this article can be secured in lots of 12 at the rate of $.04 each from The Garrard Press, 119 W. Park Ave., Champaign, Ill.



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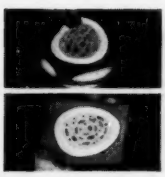

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sought by every individual who would like to climb the ladder of leadership.

In order to encourage this program, the American Dairy Science Association is giving recognition to the clubs having the most effective programs for the development of leadership of the members of their organizations. The recognition will be based on the year's activities, as presented in a scrapbook, which will be judged and displayed at the annual meeting of the Association.

The Student Affiliate Committee of the Association is now developing two new programs for individual dairy students. One will give recognition to undergraduate students who have outstanding academic and leadership records during their college careers and another will give recognition to graduate students, based on their skill in writing and presenting technical papers, as required in research activities.

There are 33 local dairy clubs in as many states that are affiliate chapters of A.D.S.A. and are taking part in this program. Over 400 students are affiliate members and receive the Journal published by the Association.

Virgina Tech Chapter Activities

The Virginia Tech Chapter of A.D.S.A. has successfully completed several outstanding projects this year. The Club published an Annual containing many pictures of Club activities and articles of various kinds. The Annual was financed by the selling of advertisements throughout the state. About 1,000 copies were mailed to people in Virginia who are interested in dairying and about 500 copies were distributed at the annual V.P.I. Agricultural Exposition.

The Club sponsored a Fitting and Showmanship Contest in which there were about 50 participants in connection with the V.P.I. Agricultural Exposition. This show was witnessed by many of the 4,000 visitors to the Exposition.

Officers elected in April for the year 1956-57 were: president—Oscar W. Kennedy, Richmond, Va.; vice-president—Charles M. Allison, Pulaski, Va.; secretary—Mason H. Hutcheson, Dinwiddie, Va.; treasurer—George B. Meyer, Richmond, Va.; reporter—Sidney Spahr, Bristol, Va.; and faculty advisor—Paul M. Reaves.

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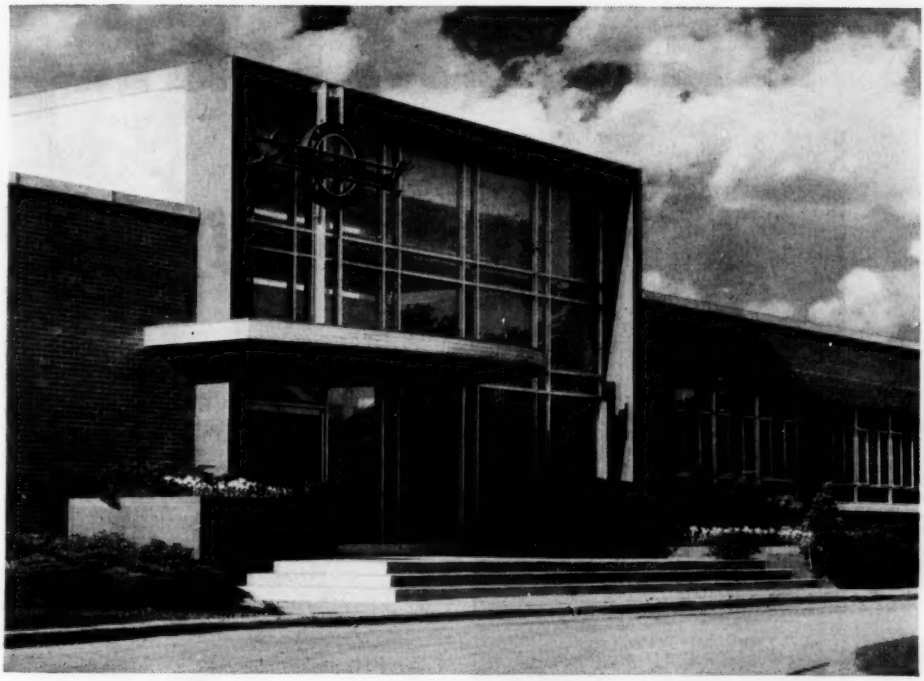

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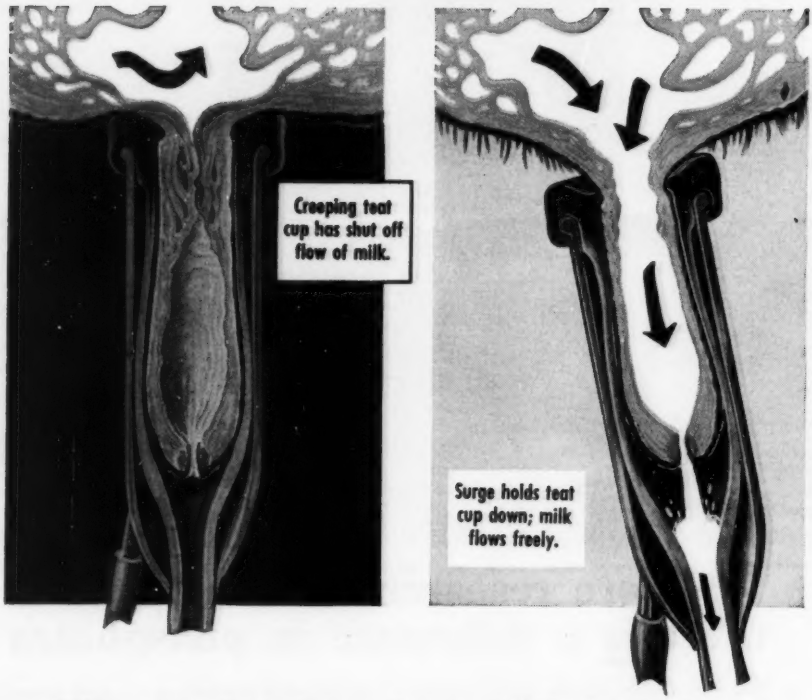

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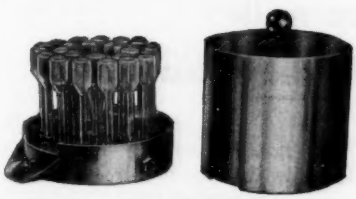

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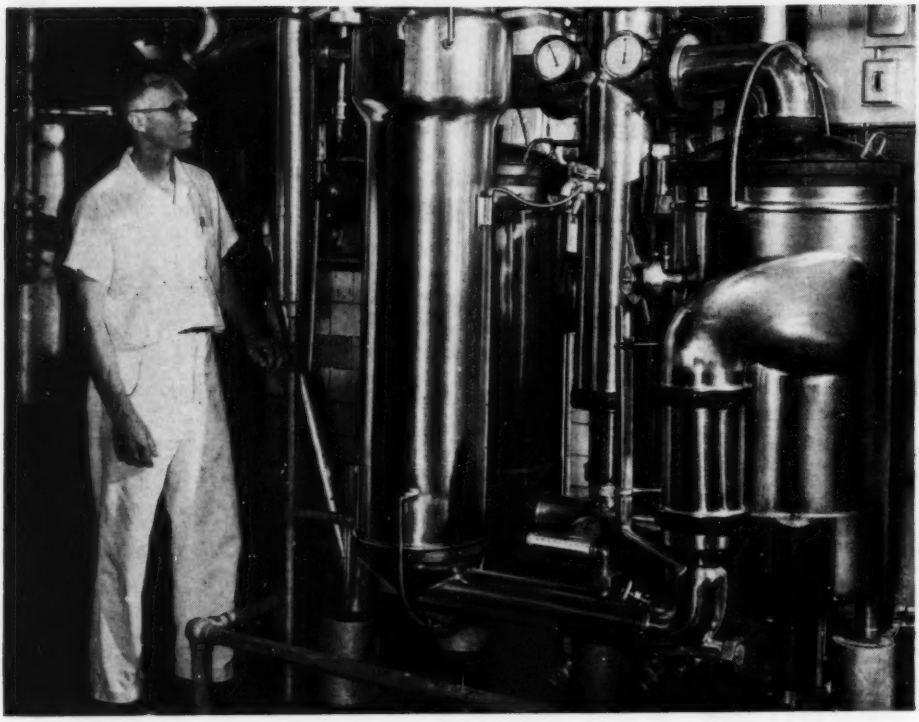

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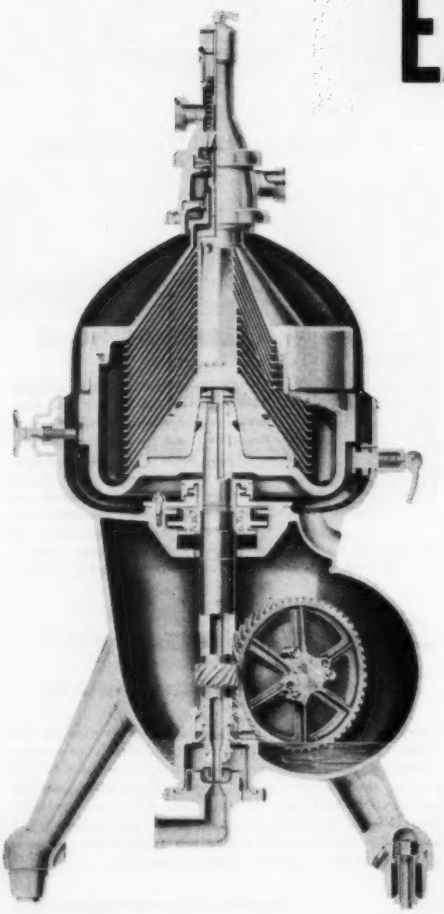

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CHEDDAR CHEESE MADE FROM PASTEURIZED MILK HOMOGENIZED AT VARIOUS PRESSURES

I. I. PETERS

Department of Dairy Husbandry, A. & M. College of Texas, College Station

Both low and high solids milks were passed through a homogenizer at pressures varying from 0 to 2,000 lb. and made into American cheese. The effects of homogenizing upon elasticity of curd at cutting time, whey expulsion from the curd, matting during cooking, fat loss in whey, and oiling off in cheese, body and texture score, and the color intensity were determined. *Editor.*

Nicholas *(4)* has published a method for the manufacture of nonfat-leaking Cheddar cheese based on homogenizing the cream portion of the milk. Zollikofer *(8)* observed that homogenization of milk at 2,000 atmospheres resulted in a more compact curd, retarded whey drainage, and decreased fat losses in whey to 0.14-0.16%. Schwartz and Mumm *(6)* have reported fat losses in whey of 0.22% and Maxcy *et al. (2)* of 0.02-0.07%. The latter workers found cheese made from fortified, homogenized milk to be very firm and higher in moisture than might have been expected from its body characteristics. Cut pieces of such cheese showed no visible leakage of fat when held on filter paper for 7 days at room temperature.

The purpose of the present study was to determine the effect of making Cheddar cheese from milk homogenized at various pressures. The use of Jersey and Holstein milk separately permitted a comparison of milk differing widely in composition. Such a comparison was believed to be of added interest and value.

METHODS

Cheddar cheese was made by a conventional method *(7)* with either Jersey or Holstein milk obtained from the College herd. Jersey milk testing 5.3-5.4% fat was standardized with skimmilk of its kind to a calculated fat:casein ratio of 1:0.7 by Van Slyke's formula, per cent casein = 0.4 (fat − 3) + 2.1 *(7)*. Holstein milk testing 3.4% fat was used unstandardized.

For each day's series approximately 800 lb. of milk was pasteurized at 143° F. for 30 minutes and cooled in the pasteurizing vat to 120° F., at which time four consecutive portions of 200 lb. each were withdrawn and homogenized in a Manton-Gaulin homogenizer at 0, 500, 1,000, and 2,000 p.s.i., respectively. The homogenized milk was cooled immediately over a surface cooler to 40° F. or below. The cooled milk was collected in 10-gal. cans, refrigerated over night, and made into cheese the following morning.

Received for publication August 1, 1955.

All cheeses were made in four identical 50-gal. stainless steel Damrow cheese vats. The same make schedule was rigidly followed with both nonhomogenized and homogenized milk. One ounce of cheese color was added to each 1,000 lb. of milk, as was 0.02% of $CaCl_2$ dissolved in water.

The curd from each lot or vat was made into four cheeses of the American favorite style. The cheese was kept in the press over night, removed from the hoops, stamped for identification, and paraffined after the rind was sufficiently dry. The paraffined cheese was cured on shelves at 50-55° F. for 6 months.

The modified butyl alcohol Babcock method was used in making fat tests on milk, whey, and cheese *(1)*. Moisture in the cheese was determined in duplicate on 5-g. samples of ground cheese dried at 105° C. for 24 hours. Fat leakage was determined on 20-g. samples of ground cheese passed once through a sausage machine with orifices of 5 mm. in diameter. Each ground, weighed sample was placed in a 100-ml. graduated cylinder. Distilled water containing 1:500 parts added formaldehyde and having a temperature below 90° F. was used to bring the contents in the cylinder to the 90-ml. mark. Samples prepared in the above manner were held for 24 hours at 98° F., transferred to plastic 100-ml. centrifuge tubes, and centrifuged for 15 minutes at 1,000 r.p.m. in a Cenco high speed centrifuge. Next, the samples were refrigerated over night at 38° F. The solidified fat was then removed and weighed without drying and is reported as grams of solidified fat separated from 20 g. of cheese.

Photographic illustrations of fat leakage were prepared from a trier plug disc of cheese cut ⅛ in. high. The cheese disc was placed in the center of a dry filter paper perviously saturated with Sudan III and kept in a petri plate. The petri plate was covered, and the cheese was exposed for 2.5 hours to air at 98° F., after which the plate and its contents were cooled in a refrigerator for 15 minutes, and the picture was taken immediately.

All cheeses were judged at the ages of 3 and 6 months as outlined by Nelson and Trout *(3)*. The identity of the samples was withheld from the judge in all instances.

RESULTS

Homogenizing milk at increasing pressures resulted in decreasing elasticity of curds at cutting time. It also resulted in retarded whey expulsion from curds during cooking and cheddaring, and was especially noticeable during salting. At this stage curds made from milk homogenized at 2,000 p.s.i. yielded insufficient amounts of whey for the determination of titratable acidity. Whey acidities determined prior to salting of cheese were similar in value, ranging from 0.14 to 0.15% at dipping time.

Homogenizing milk at increasing pressures resulted also in decreasing matting of curds during cooking, which may be considered desirable, and in slower and less complete matting of curd during cheddaring and pressing, which may be considered undesirable. The slower matting of the curd in the hoop was accompanied by a slightly less satisfactory rind and by slower drying of the rind prior

TABLE 1

The influence of homogenization pressure of milk upon fat loss in whey, per cent oiling off and per cent moisture in cheese

Milk homogenized at p.s.i.	Item studied		
	Per cent fat loss in whey	Per cent oiling off in cheese[a]	Per cent moisture in cheese
	Jersey-Holstein	*Jersey-Holstein*	*Jersey-Holstein*
0	0.30-0.22	41-48	37.2-35.6
0	0.32-0.32	48-46	36.0-36.2
500	0.24-0.22	31-34	37.6-37.3
500	0.20-0.25	35-37	35.1-36.0
1,000	0.23-0.18	22-27	37.5-36.9
1,000	0.17-0.20	28-31	36.0-36.0
2,000	0.12-0.14	18-21	37.8-36.2
2,000	0.17-0.18	20-21	35.7-36.0

[a] Based on grams of free solidified fat obtained from 20 g. of ground cheese.

to paraffining. However, none of the rinds were sufficiently poor to cause surface deterioration of the paraffined cheese during ripening.

Progressive increases in homogenization pressure resulted in corresponding decreases in per cent fat in whey and in oiling off in cheese, as shown in Table 1. No definite relationship was observed between treatment of milk and per cent moisture in cheese.

Numerical scores of 3- and 6-month-old cheese are shown in Table 2. Although none of the cheese judged exhibited any pronounced flavor defects, nevertheless some differences in intensity and types of flavors were observed. All of the 3-month-old cheeses and some of the 6-month-old cheeses were criticized as being flat or slightly flat. Cheeses made from milk homogenized at 2,000 p.s.i. showed the least flavor development during aging. The greatest improvement in flavor was found in cheeses made from both Holstein and Jersey milk homogenized at

TABLE 2

Flavor, body, and texture scores of 3- and 6-month-old cheese

Origin of milk	Scores of cheese from milk homogenized at pressures of:							
	0 p.s.i.		500 p.s.i.		1,000 p.s.i.		2,000 p.s.i.	
	3 mo.	6 mo.	3 mo.	6 mo.	3 mo.	6 mo.	3 mo.	6 mo.
				Flavor				
Holstein	38.5	40	39	40	38.5	40	38.5	39.5
Holstein	38	40	39	40	38.5	39	38.5	39
Jersey	39	39	37.5	39.5	39	39	38.5	38.5
Jersey	39	40	40	40	39.5	40	39	39
Mean	38.6	39.75	38.9	39.9	38.9	39.5	38.6	39
				Body and texture				
Holstein	27	28	28	28.5	28	28.5	27.5	28
Holstein	28	28.5	28	28.5	28	28.5	28.5	28
Jersey	27	28	28	28.5	28.5	28.5	28	27.5
Jersey	27	28	27.5	28.5	28	29	27	28
Mean	27.25	28.1	27.9	28.5	28.1	28.6	27.75	27.9

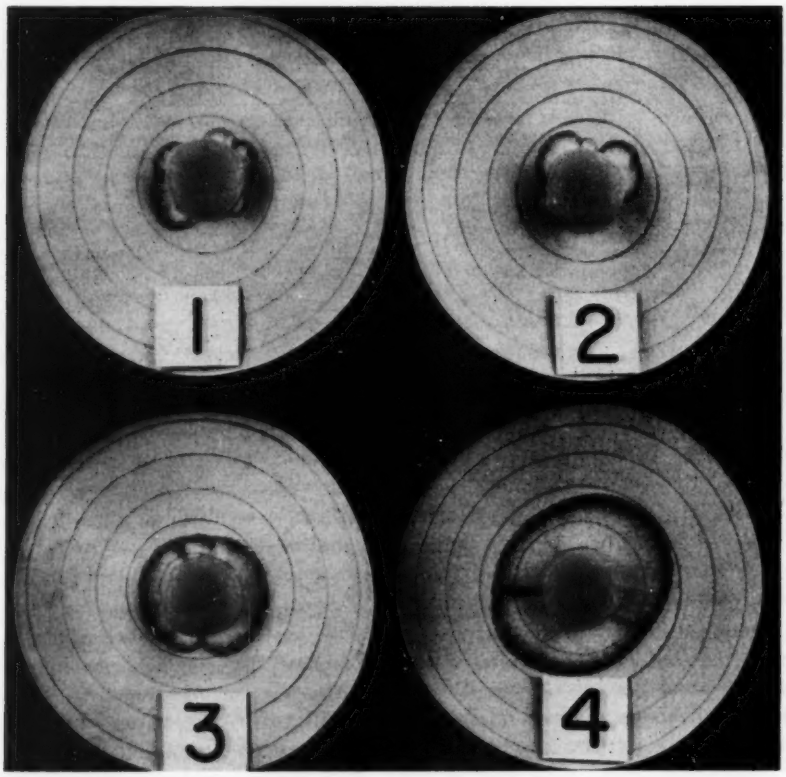

FIG. 1. The influence of homogenization pressure of milk upon fat leakage in cheese made from standardized Jersey milk homogenized at (1) 2,000, (2) 1,000, (3) 500, and (4) 0 p.s.i.

500 p.s.i., followed by 1,000 and 0 p.s.i., respectively. Although flavor differences were observed, analysis of variance showed them to be statistically nonsignificant.

The differences in body and texture scores of the various lots of cheese were found to be statistically significant between the 0.1 and 0.05 levels of probability of chance occurrence. The most common texture criticism was that of mechanical openings, which defect was of similar magnitude and frequency in all lots of cheese. Three lots of cheese made from milk homogenized at 2,000 p.s.i. were criticized as being curdy when 3 months old, with two of the lots still being curdy after 6 months of ripening.

Increasing homogenization pressures of milk progressively decreased the color intensity of the manufactured cheese. This trend was more pronounced with cheese from Jersey milk. No statistical difference was found between Holstein and Jersey milk cheese.

Figure 1 is a photographic illustration of fat leakage in cheese made from Jersey milk, treated in the manner described above. Although some fat leakage

is desirable in order to give cheese its palatability and richness in taste, the extent of fat leakage exhibited by Sample 4 was considered excessive and less desirable than that exhibited by Sample 3. Holstein milk cheese showed fat leakage similar to that portrayed in Figure 1. A comparison between Figure 1 and data on oiling off in Table 1 indicates a correlation between the two tests.

DISCUSSION

The manufacture of Cheddar cheese from homogenized milk, especially at 500 and 1,000 p.s.i., offers certain advantages over the use of nonhomogenized milk. Because of lower fat losses in whey, closer standardization may be practiced *(6)*. Homogenization of milk even at low pressures retards creaming of milk during setting time, thus favoring a more uniform distribution of fat globules throughout the curd. Homogenization pressures of 500 and 1,000 p.s.i., although decreasing somewhat the elasticity and matting property of the curd, still permit the formation of a curd that will cut and handle well during cooking and cheddaring. With 2,000 p.s.i. the curd was somewhat brittle, which resulted in losses of fine curd fragments in the whey.

The apparently more tenacious moisture-holding properties of cheese made from homogenized milk may be of advantage in retarding moisture losses during curing, as has been observed with Blue cheese *(5)*.

SUMMARY

Cheese of the Cheddar type was made from either standardized Jersey milk or unstandardized Holstein milk homogenized at 0, 500, 1,000, and 2,000 p.s.i. Increasing homogenization pressures resulted in progressive decreases in elasticity of curd, slower whey expulsion, lower fat losses in whey, lower color intensity of cheese, and less oiling off.

Analysis of variance showed nonsignificance with respect to breed differences and to differences in flavor scores of the ripened cheese. The differences in body and texture scores were found to be significant between the 0.1 and 0.05 level of probability of chance occurrence, with 500 and 1,000 p.s.i. resulting in a superior body and texture.

ACKNOWLEDGMENT

The author is indebted to R. R. Shrode of the Genetics Department for the statistical analysis of the data.

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CHARACTERISTICS OF A SWEETENED FLUID CONCENTRATED MILK PRODUCT AS AFFECTED BY PROCESSING AND STORAGE CONDITIONS[1]

P. M. LARGE,[2] T. D. HARMAN, AND I. A. GOULD
Department of Dairy Technology, The Ohio State University, Columbus

Storage qualities of a product containing 20% fat, 18% m.s.n.f., and 30% sugar (cane and corn syrup solids) processed at different temperatures and stored at −10°, 40°, and 70° F. were studied. The effects upon viscosity, flavor, −SH compounds, bacterial changes, and sugar crystallization were determined. *Editor.*

The storage of milk fat in the form of frozen cream and of solids-not-fat as frozen condensed skimmilk is a common practice in the commercial dairy industry. These products, however, are likely to develop certain major defects during storage, such as oxidized and stale flavors and physical changes in fat and protein dispersion.

Within recent years, limited attention has been given to the preparation and storage of a concentrated milk product which could be stored under refrigerated, but not necessarily freezing, conditions and would not be subject to the usual physical and chemical changes *(3, 5)*. Johnson and Olson *(3)* studied a concentrated ice cream mix containing 23% milk fat and 80% total solids and found it to be completely satisfactory after 6 months storage at 50° F. and after 1 year at 0° F.

Olson *(5)* prepared two products, each containing 40% milk fat and 20% milk solids-not-fat. One was obtained by standardizing 47% cream to 40% with nonfat dry milk solids, and the other was prepared by condensing a 15% cream to 40% milk fat. The former product developed a "stale powder" flavor on storage. Both products exhibited fat stability superior to that of 40% cream similarly frozen and stored.

This paper deals with a study on a sweetened concentrated product of the following approximate composition: 20% milk fat, 18% milk solids-not-fat, and 30% sugar. The objectives of this study were to determine the effect of: *(a)* processing conditions, *(b)* the use of combinations of cane and corn sweeteners, and *(c)* the storage conditions on the characteristics of the product.

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PROCEDURE

Basic mix. The basic mix was prepared from fresh milk, cream, and cane sugar, blended in such proportion that after vacuum pan concentration the finished product had a composition of 20% milk fat, 18% milk solids-not-fat, and 30% cane sugar. Modifications of this mix were made by substituting corn sugar or corn syrup solids for one-third of the cane sugar on the basis of sweetening equivalent. In each series, three mixes were prepared: *(a)* the basic mix, *(b)* the basic mix modified to contain 20% cane sugar and 12.5% corn sugar, and *(c)* the basic mix modified to contain 20% cane sugar and 20% corn syrup solids. The corn syrup solids were reported to contain 21% dextrose, 35% maltose, and 44% dextrins.

Processing and storage. All ingredients were blended in a stainless steel vat, warmed to 140° F., and held for 20 minutes; homogenized at 2,000 p.s.i. on the first stage and 500 p.s.i. on the second stage; cooled to 40° F. and divided into three lots. Lot 1 was forewarmed at 165° F. for 30 minutes, Lot 2 at 185° F. for 30 minutes, and Lot 3 at 200° F. for 30 minutes. After forewarming, each lot was condensed on a vacuum pan operating at approximately 28″ Hg (100° F.). The attempt was made to bring the product to the desired concentration in the vacuum pan so that subsequent adjustment would be unnecessary. However, in a limited number of cases, slight over-condensing occurred, which necessitated subsequent diluting with water. Also, in the lots containing corn syrup solids, it was found necessary to draw off some of the batches at milk solids concentrations somewhat lower than that of the basic mix because of the high viscosity produced.

The concentrated products were standardized, promptly cooled to approximately 50° F., and hermetically sealed in plain tinned No. 2 Canco cans. The various lots were stored at –10° F., 40° F., and 70° F.

Methods of analysis and examination. Immediately after processing, and periodically thereafter, samples were taken from each lot and examined for the following: sulfhydryl compounds, viscosity, pH, titratable acidity, stability of milk fat emulsion, homogenization efficiency, microbiological changes, flavor, and texture.

Sulfhydryl compounds were determined on each lot by first diluting the sample, 1 to 1 by weight, with distilled water and using the thiamine disulfide method of Harland and Ashworth *(2)*. The results are expressed as milligrams cysteine HCl per liter.

The viscosity of the products was measured at 30° C. on a Gardner Mobilometer calibrated with sugar solutions. The results are expressed as centipoise (cps.).

Bacterial and coliform counts were made in accordance with standard methods *(1)*; pH was determined with a Beckman glass electrode potentiometer and the titratable acidity by diluting 9 g. of the condensed product with 9 ml. distilled water and titrating with 0.1 *N* NaOH with phenolphthalein as the indicator. The homogenization efficiency was determined by the method of Maxcy *(4)* as modified by Seiberling *(6)*. The flavor and texture were evaluated on coded samples by four judges working independently.

RESULTS

Viscosity. The viscosities of various lots are shown in Table 1. These results reveal that the viscosities of the product containing cane sugar alone and cane and corn sugar were increased directly with the forewarming temperature. This direct relationship was not exhibited by the corn syrup solids series. The viscosity values were higher for the lots with corn sweeteners than for those with cane sugar alone. In fact, the product containing corn syrup solids frequently had viscosities that were too high to be measured.

TABLE 1

Viscosity of the concentrated products as affected by forewarming temperatures, sweeteners, and storage temperatures (Values expressed as centipoise at 30° C.)

Forewarming temp.	Storage temp.	Product containing: Cane sugar alone		Cane sugar and corn sugar		Cane sugar and corn syrup solids	
		Fresh	60 days	Fresh	60 days	Fresh	60 days
(° F.)	*(° F.)*	*(cps.)*	*(cps.)*	*(cps.)*	*(cps.)*	*(cps.)*	*(cps.)*
165		561		860		9,213	
	−10		411		637		4,300
	40		437		767		6,264
185		845		2,460		3,530	
	−10		670		2,440		3,220
	40		760		3,440		3,690
200		990		2,700		4,680	
	−10		920		2,825		2,760
	40		891		3,010		2,610

Results shown in Table 1 further reveal that the viscosities of the products were not markedly affected by the storage temperature and times although the lots containing corn syrup solids were generally lower in viscosity after 60 days storage than at the beginning, and the viscosities of the lots stored at 40° F. were generally slightly higher than the viscosities of the lots stored at −10° F.

During the processing of the various lots, it was revealed that two variations in the processing procedure lowered the viscosity of the products to a marked degree: *(a)* adding the sweetener late in the condensing process and *(b)* standardizing slightly over-condensed lots with water. The results of these variations in procedure are shown in Table 2.

These data reveal that adding the sugar, as a syrup, late in the condensing process resulted in a product that possessed a much lower viscosity than the lots to which the sweetener was added during the forewarming of the milk.

The results in Table 2 also reveal that a small reduction in the total solids content of the over-condensed lots by the addition of water resulted in marked and permanent decreases in viscosity, which appeared to be out of proportion to the small amount of water added. This effect may be utilized to advantage in the plant that desires a highly fluid product for ease of handling.

TABLE 2

Viscosity of concentrated products as affected by time of adding sweetener or water standardization of over-condensed lots (Values expressed as centipoise at 30° C.)

Effect of time of adding combination cane sugar and corn syrup solids	
Time of adding sweeteners	Viscosity of concentrated product
	(cps.)
Prior to condensing as dry sugar	3,716
Near end of condensing period as a syrup	921

Standardizing over-condensed lots with water

Lot No.	Total solids		Viscosity	
	Prior to standardization	After standardization	Prior to standardization	After standardization
	(%)	*(%)*	*(cps)*	*(cps)*
1	71.0	68.0	1,228	461
2	70.0	68.0	875	445
3	73.4	70.5	3,117	568
4	71.4	70.5	2,196	798

Sulfhydryl compounds, cooked, and oxidized flavors. Sulfhydryl measurements were made on the standardized fluid products after forewarming and before condensing and on the condensed products. Results are presented in Table 3.

These results reveal that: *(a)* the type of sweetener did not appear to have any appreciable effect on the quantity of active sulfhydryl compounds produced by forewarming, *(b)* appreciable quantities of active sulfhydryl compounds were produced by the 185° F. and 200° F. treatment with somewhat lower concentration at the higher forewarming temperature. This may indicate that if the maximum sulfhydryl compound production is desired, the lower temperature is preferred.

The condensing operation subsequent to forewarming did not have any marked effect on the active sulfhydryl group concentration produced during forewarming. For example, the average value for the active sulfhydryl compounds as calculated from solids increase for the heat treatment of 200° F. was 22.6 mg. cysteine HCl per liter, and the average actual value was determined as

TABLE 3

Active sulfhydryl compound content of the concentrated product as affected by forewarming temperature and different types of sweeteners (Sulfhydryl values expressed as mg. cysteine HCl/l)

Forewarming temp.	Cane sugar alone		Cane sugar and corn sugar		Cane sugar and corn syrup solids	
	T.S.	–SH Compounds	T.S.	–SH Compounds	T.S.	–SH Compounds
(° F.)	*(%)*	*(mg/l)*	*(%)*	*(mg/l)*	*(%)*	*(mg/l)*
165	68.0	3.7	69.9	3.8	67.6	1.9
185	68.0	25.6	67.7	23.9	65.6	24.5
200	68.0	21.3	67.5	18.9	60.9	16.6

TABLE 4

Decrease of active sulfhydryl compounds in the concentrated product as affected by time and temperature of storage (Sulfhydryl values expressed as mg. cysteine HCl/l)

Fore-warming temp.	Storage temp.	Original SH conc.	Percentage of original sulfhydryl compound remaining after:			
			30 days	60 days	120 days	180 days
(° F.)	*(° F.)*	*(mg/l)*	*(%)*	*(%)*	*(%)*	*(%)*
185	–10	25.6	81.8	61.1	40.9	33.9
200	–10	21.4	80.0	61.8	35.5	26.8
185	40	25.6	52.1	36.3	17.9	11.8
200	40	21.4	66.5	49.0	20.5	14.4

21.3 mg. per liter. These results indicate that, in this system, the active sulfhydryl compounds produced were relatively nonvolatile.

The flavor examinations revealed no relationship between the forewarming temperature, the concentration of the sulfhydryl compounds, and any type of heat-produced flavor. The so-called "cooked" flavor that is characteristic of fluid milk heated to high temperatures was absent from these lots and, often, the judges indicated the products heated to 165° F. possessed more of a "heated" flavor than those processed at the higher temperatures.

The change in concentration of the active sulfhydryl groups during storage at 40° F. and –10° F. is shown in Table 4. After 6 months of storage, 13% and 30% of the original sulfhydryl compounds remained in the lots stored at 40° F. and –10° F., respectively. The type of sweetener had no noticeable effect on this change.

The nonbacterial flavor stability of the samples stored at 40° F. and –10° F. was highly satisfactory. After 6 months storage a stale flavor was noted in cer-

TABLE 5

Bacterial count and flavor of concentrated product as affected by storage temperature and time by type of sweetener (Results represent 6 trials)

Sweetening agent	Temp. of storage	Time of storage					
		30 days		60 days		180 days	
		Bact. count	Flavor	Bact. count	Flavor	Bact. count	Flavor
	(° F.)	*(org/g)*		*(org/g)*		*(org/g)*	
Cane sugar alone	–10	550	good	445	good	630	good
	40	1,480	good	1,960	good	7,480	good
	70	3.2M	sour	—	—	—	—
Cane sugar and corn sugar	–10	330	good	670	good	825	good
	40	870	good	1,100	good	1,050	good
	70	0.4M	[a]	8.2M	[b]	—	—
Cane sugar and corn syrup colids	–10	770	good	1,200	good	1,100	good
	40	1,200	good	1,400	good	1,200	[d]
	70	16.0M	[c]	14.4M	sour	—	—

[a] 2 sour, 1 stale.
[b] 2 "storage," 1 sour.
[c] 3 lots good, 3 stale.
[d] 5 "storage."

tain lots containing corn syrup solids. This flavor defect occurred in one of the 18 lots stored at –10° F. and in five of the 18 lots stored at 40° F. The average active sulfhydryl compound content of the samples that exhibited staleness was 1.72 mg. cysteine HCl per liter, as contrasted to 3.1 mg. for the samples that did not exhibit the defect.

Storage temperature and bacterial changes. One of the primary aims of this study was to determine the bacterial keeping quality of the 2:1 concentrated product at –10° F., 40° F., and 70° F. Results of bacteriological studies are presented in Table 5.

The product usually underwent appreciable bacterial spoilage within 1 month when stored at 70° F. but exhibited no spoilage during 6 months of storage at 40° F. and –10° F. At 70° F. storage, the lots containing corn sweeteners exhibited a slightly better bacterial keeping quality than those containing sucrose alone, but the difference was no practical significance.

The titratable acidity and pH changes that occurred during storage (not shown) paralleled the spoilage and bacterial changes.

Texture. Results of the examination of the –10° F. and 40° F. lots for sugar crystallization are shown in Table 6.

TABLE 6

Occurrence of sugar crystallization in the concentrated product during storage[a]

Sweetener	Storage temp.	Storage period in days					
		30		60		180	
		Trial No.		Trial No.		Trial No.	
		1	2	1	2	1	2
	(° F.)						
Cane sugar alone	–10	++	0	++	0	0	++
	40	++	++	+++	++++	++	+++
Cane sugar and corn sugar	–10	0	0	0	+	0	+
	40	0	0	0	+	0	++
Cane sugar and corn syrup solids	–10	0	0	0	0	0	0
	40	0	0	0	0	0	0

[a] 0 = none, + to 4+ represents slight to pronounced crystal formation.

The sugar crystallization was much more prevalent and in greater intensity in the samples that contained cane sugar alone. Most of the samples containing part corn sugar displayed little or no crystallization. In the instances when it did occur, the crystallization was more intense in the samples stored at 40° F.

There was no apparent relationship between the incidence of crystallization and viscosity. The lots with extremely low viscosities produced by overcondensing and then standardizing with water exhibited no more sugar crystallization than the normal lots with much higher viscosities. The crystals were found to be

from the added sweeteners and not lactose, and they dissolved quickly when the concentrated product was diluted for processing.

General observations on the stored product. Observations revealed no major differences in the products from the standpoint of discoloration and age thickening. In addition, the normal emulsion of milk fat was not noticeably affected. The homogenization efficiency was satisfactory in all cases and no fat separation or oiling off was evident when the product was being processed into ice cream.

SUMMARY

Studies were made of the effect of processing and storage conditions on the keeping quality and characteristics of a product containing approximately 20% milk fat, 18% milk solids-not-fat, and 30% sugar. In certain lots, one-third of the sugar was replaced with corn sugar or corn syrup solids on an equivalent sweetness basis. Forewarming temperatures used were 165° F., 185° F., and 200° F. and storage was at –10° F., 40° F., and 70° F.

The products heated to 185° F. contained appreciably more sulfhydryl compounds than those heated to 200° F.; however, there was no apparent relationship between the amount of sulfhydryl compounds and the "cooked" or "heated" flavor.

From both a bacteriological and oxidative spoilage standpoint, the products were found to have excellent keeping qualities when stored for 6 months at 40° F. and –10° F., but they underwent rapid bacterial spoilage when stored at 70° F.

None of the samples exhibited the typical oxidized flavor after 6 months storage, even though, in some samples, the sulfhydryl group content had been practically eliminated. However, there was a tendency for the lots containing corn syrup solids to develop a stale flavor.

In general, the viscosity of the product increased directly with the temperatures of forewarming. Higher viscosities occurred in the samples containing partial substitution of the cane sugar with corn sugar or corn syrup solids, the latter having the greatest viscosity.

The viscosity was decreased by: *(a)* adding the sugar as syrup late in the condensing process and *(b)* overcondensing slightly, viz., 1—2%, and standardizing to the desired composition with water. The latter practice, which produced large decreases in viscosity, may be used to advantage in plants where movement of the product by pumping is desirable.

Crystals of the added sweeteners developed during storage in the product containing cane sugar alone but to a lesser extent or not at all in the lots containing corn sweeteners.

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PROTEOLYTIC ENZYMES IN HUMAN AND COW'S MILK

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Results obtained from feeding infants enzyme-treated milk suggest that the superiority of such milks may be associated with the added enzyme rather than with any physical or chemical changes in the milk proteins. Tests were made to determine the possible presence of the enzyme in treated cow's milk after pasteurization, and in human milk. The results provide a new concept in infant nutrition. *Editor.*

The production of low curd-tension milk by modification with pancreatic enzymes was first proposed by Conquest *et al. (4)* in 1938. Later, a considerable amount of clinical investigation on such a product was reported by Blatt *et al. (3)* and Steigmann and Blatt *(10)*. They showed that excellent results were obtained in infant nutrition with this modified milk and suggested its use in other situations where intolerance to cow's milk might be encountered. Blatt recommended the use of this milk unboiled, either diluted or undiluted, for the feeding of infants. Hess and Lundeen *(6)* at Michael Reese Hospital confirmed Blatt's work, obtaining good results when feeding unboiled Enzylac[2] to premature, as well as newborn, infants.

These results suggested that the successful use of enzyme-treated milk might be due to something more than curd tension reduction. It was assumed that the additional effect was associated with the added pancreatic enzymes themselves, rather than with any physical or chemical change they might have had upon the proteins, such as reduction of curd tension or the liberation of proteoses, peptones, and amino acids.

Enzyme-treated milk is produced commercially by adding pancreatic enzymes to raw milk, bringing the milk to pasteurization temperature (143° F.), holding it for 30 minutes, and then immediately cooling. While the milk is being heated, the enzymes act upon the milk proteins. The degree of hydrolysis has been estimated at only about 1% *(12)*, which is insufficient to alter the appearance or flavor of the milk.

It was assumed that the heat of pasteurization completely inactivated the added pancreatic enzymes, although occasionally low protein stability *(11)* is

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[2] Enzylac is the trade name for milk modified by a special pancreatic enzyme concentrate produced by the Armour Laboratories, a Division of Armour and Company, Chicago, Illinois. Enzylac is sold nationally by Medical Dairy Specialties of Chicago and its franchisees under license from the American Seal-Kap Corp., Long Island City, New York.

observed when treated milk is held for extended periods. From the commercial point of view protein instability has not been significant. From an academic viewpoint, however, it seemed desirable to determine the cause. Later experience seemed to indicate that a significant amount of enzyme activity might persist through pasteurization. The work reported in this paper was undertaken to study the effect of pasteurization upon proteolytic enzymes in milk, as well as to learn more about the enzyme activity of Enzylac milk and human milk.

EXPERIMENTAL PROCEDURE AND RESULTS

Tests for heat inactivation of enzymes in enzyme-treated milk. The enzyme used in this study was a special pancreatic concentrate used for the commercial production of Enzylac milk. It was added to whole milk at the level of 80 p.p.m., and the milk was then pasteurized in glass by heating to 143° F. and holding for 30 minutes. After pasteurization, the samples were cooled immediately in ice water and stored in a refrigerator. On the following day, after the addition of the necessary amount of antibiotic as indicated below, the samples were warmed to 100° F. and held at that temperature up to 6 hours, during which time the rate of enzymatic hydrolysis was followed by the determination of tyrosine by the Hull method *(7)*. The method was modified slightly by using S & S No. 597 filter paper instead of No. 595 in order to remove the milk proteins more completely before measuring the tyrosine colorimetrically. Occasionally it was neces-

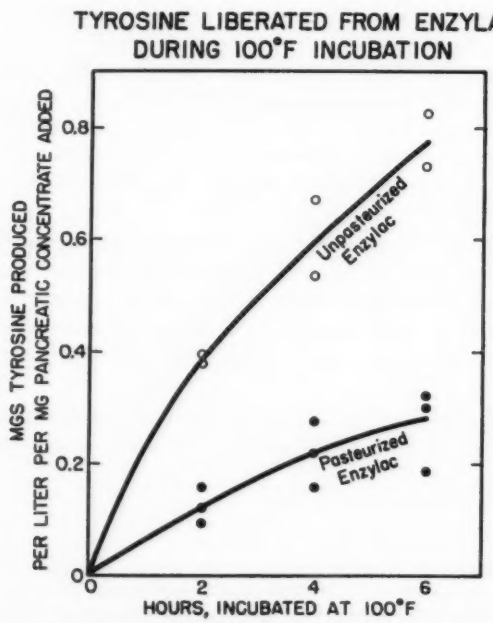

FIG. 1. Heat inactivation of proteolytic enzymes in Enzylac.

sary to either filter or centrifuge the final solution to remove a white granular precipitate, which interfered with the colorimetric reading.

For comparison, pancreatic enzyme concentrate was added to antibiotic-treated raw whole milk in the same quantities and the samples were incubated at 100° F. for 6 hours, followed by a measurement of the tyrosine.

The results of these tests, shown in Figure 1, have been expressed in milligrams of tyrosine produced per liter of milk per milligram of pancreatic enzyme concentrate added. This method of expression makes possible a ready comparison of rates of activity observed with varying enzyme concentrations. The results show only the additional tyrosine produced by enzymatic action rather than the total tyrosine in the samples. This was calculated by subtracting the tyrosine values of the appropriate untreated control samples run concurrently. It appears that about one-third of the added pancreatic enzymes are not inactivated by pasteurization.

It was suggested that this residual activity of enzyme-treated milk is a factor in the effectiveness of this milk as an infant food. It was considered possible that nature might provide enzymes in human milk to aid the infant during the difficult period of adjustment from prenatal nutrition via the placenta to postnatal oral feeding. Consequently, a series of experiments was planned to determine the proteolytic enzyme activity of human milk as well as that of cow's milk.

Enzyme content of cow's milk and human milk. To demonstrate the presence of native enzyme activity in raw human milk and raw cow's milk, it was first necessary to eliminate any bacterial fermentation and consequent protein hydrolysis. Several anti-microbials, including chlortetracycline (Aureomycin), streptomycin, and hydrogen peroxide, were tried without success; finally, a mixture of bacitracin and polymyxin B was found to be satisfactory. The results obtained upon a sample of raw cow's milk with a high bacteria content are shown by samples A1 and A2 in Table 1. Total and proteolytic bacteria counts were made at the beginning and at the end of the 6-hour, 100° F. incubation period.[3] One-hundred-ml. samples of milk in 250-ml. glass-stoppered Erlenmeyer flasks were held at 100° F. Samples were removed periodically, and the tyrosine content was determined.

The results obtained from samples A1 and A2 show a large increase in the total bacteria count during the 6-hour incubation period but a decreasing proteolytic count during this period. The addition of the antibiotics decreased the total and proteolytic counts appreciably. The effect of the bacteria upon the liberation is shown in the last group of figures. The milk sample without antibiotics liberated about four times as much tyrosine as the one containing antibiotics. Evidently this high tyrosine liberation is caused by the effect of the bacteria on the milk protein or is indicative of a breakdown of bacterial proteins. In either case, it appeared desirable to use milk samples containing as few bac-

[3] Total bacteria counts were made by Standard Plate Count *(1)*, except that an incubation temperature of 98.6° F. was used. Proteolytic counts were made by counting the clear zones encircling the bacterial colonies after plating the colonies on Difco Plate Count Agar containing 1% skimmilk powder and incubating at a temperature of 98.6° F.

TABLE 1

Effect of antibiotics on bacteria counts and tyrosine liberation in high and low bacteria count milks

Sample	Antibiotics added *(mg.)* to 100 ml. milk		Enzylac added *(p.p.m.)*	Bacteria counts per ml.				Tyrosine liberated *(p.p.m.)*		
				Total		Proteolytic				
	Bacitracin	Polymyxin B		0 hr.	6 hr.	0 hr.	6 hr.	2 hr.	4 hr.	6 hr.
A1	None	None	None	965,000	208,000,000	17,650	2,295	12.0	16.0	20.4
A2	156	15	None	390,000	65,000	13,150	675	3.0	4.0	6.0
B1	None	None	None	180	28,800	30	15,000	0.0	1.5	1.5
B2	156	15	None	30	<10	20	<10	1.8	1.8	3.2
C1	None	None	None	950	299,500	20	78,500	1.5	3.0	11.7
C2	None	None	80	—	107,500	—	24,600	33.0	48.5	63.5
C3	156	15	80	—	1,300	—	1	30.2	42.7	58.3

teria as possible in order to have a minimum effect on the enzyme-protein system in the milk. The effect of a low bacteria count raw milk upon tyrosine liberation was carried out in an experiment with raw cow's milk taken as aseptically as possible from a cow free from mastitis. The results of this experiment are shown in Table 1 by samples B1 and B2 and indicate that a very small amount of tyrosine was liberated in either the sample with or that without antibiotics. These results indicate that the antibiotics used in this experiment do not inhibit the liberation of tyrosine from milk; however, to obtain a more complete answer to this question, the experiments conducted upon samples C1, C2, and C3 were carried out with another sample of raw cow's milk having a low bacteria count. These results indicate a comparable liberation of tyrosine by the enzymes in enzyme-treated milk with or without added antibiotics. The slight increase noted in the second sample was probably caused by the bacteria that developed because no antibiotic was present to inhibit them.

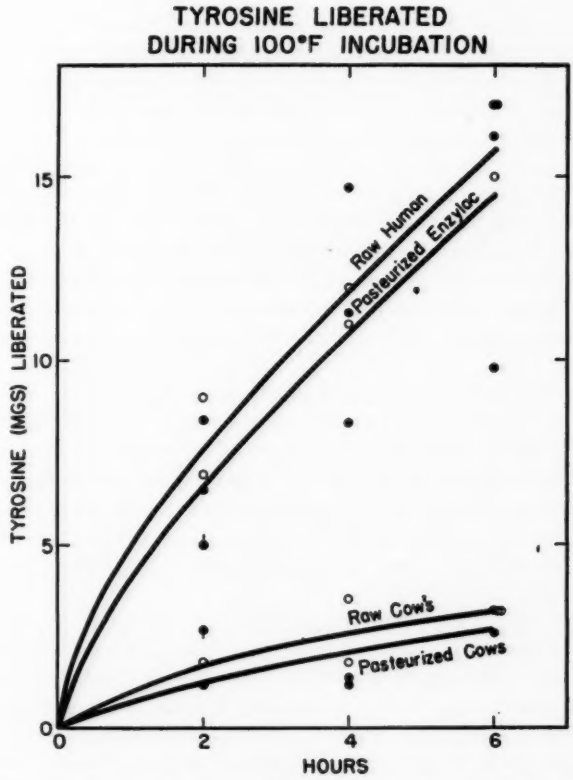

FIG. 2. Proteolytic enzymes in various milks. (Upper o = raw human, upper • = pasteurized Enzylac, lower o = raw cow's, and lower • = pasteurized cow's)

Samples of raw human milk, raw cow's milk, pasteurized cow's milk, and pasteurized enzyme-treated cow's milk were carried through a similar experiment. The bacteria counts on all these milks were below 1,000 per milliliter. The results indicate that raw human milk and enzyme-treated cow's milk contain substantially equal amounts of proteolytic enzyme as judged by the liberation of tyrosine at 100° F. Raw or pasteurized cow's milk contains about one-fifth as much proteolytic enzymes as either raw human milk or pasteurized enzyme-treated cow's milk (Figure 2).

DISCUSSION

The finding that human milk contains appreciable quantities of proteolytic enzymes is of considerable interest nutritionally. The presence of proteolytic enzymes in human milk undoubtedly provides the infant with significant digestive assistance in its attempt to bridge the difficult period of adjustment from prenatal nutrition via the placenta to postnatal oral feeding.

The results reported here substantiate the experience gained through the commercial production of enzyme-treated milk, that there are appreciable quantities of proteolytic enzymes to be found in this pasteurized milk. The fact that the enzyme-treated milk has a comparable amount of proteolytic enzymes to that found in human milk may be one of the reasons that it is so well utilized by premature, as well as newborn, infants.

Attempts to provide the infant with a milk similar in composition to human milk by modifying cow's milk have not been entirely successful, as judged by the variety of infant feeding formulas that are in use and the number of proprietary foods available. The fact that babies do best when fed breast milk supports the theory that human milk contains something not found in cow's milk. The presence of proteolytic enzymes in human milk may be responsible for the differences observed between infants fed human milk and those fed cow's milk.

The intake of additional enzymes in the foods entering the intestinal tract, where optimum conditions for their activity ordinarily prevail, might conceivably provide a significant "booster" effect which could be of assistance to individuals with lowered pancreatic activity. There is reason to suspect that such conditions do occur in young infants *(2, 9)*, in some elderly people, and perhaps in some persons with allergies. The use of the amino acid tyrosine in the treatment of allergies *(13)* supplies a possible explanation for the value of enzyme-treated milk in such cases.

The work reported here does not indicate the critical temperature at which proteolytic enzymes are inactivated. However, evaporated milk, which is exposed to a sterilization temperature of 240° F., contains no proteolytic activity *(5)*. It would be logical to expect that the boiling of milk, a common practice in the feeding of infants, would also inactivate all proteolytic enzymes *(8)*. According to the results shown in Figure 2, pasteurization does not inactivate the proteolytic enzymes in cow's milk. It is anticipated that some temperature between 143° and 212° F. would be the critical inactivation point for these enzymes.

Proteolytic enzymes taken orally in nonprotein solutions would be digested by the pepsin in gastric juice. However, if these same enzymes were added to a food containing considerable protein, such as milk, the enzymes would be protected by the attenuation of the pepsin by these proteins. Pancreatic enzymes are inactive in an acid medium, such as the stomach provides *(8)*, but upon return to a neutral or alkaline medium, they regain their activity with little loss of potency.

SUMMARY

Human milk contains proteolytic enzymes. About one-third of the proteolytic enzymes added to cow's milk in the processing of enzyme-treated milk survive pasteurization. Human milk and pasteurized enzyme-treated cow's milk contain substantially equal amounts of proteolytic enzymes. Raw or pasteurized cow's milk contains about one-fifth as much proteolytic enzyme as either raw human milk or pasteurized enzyme-treated milk. These results provide a new concept in the nutrition of infants as well as others who do not tolerate cow's milk.

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THE COCONUT-LIKE FLAVOR DEFECT OF MILK FAT. I. ISOLATION OF THE FLAVOR COMPOUND FROM BUTTER OIL AND ITS IDENTIFICATION AS δ-DECALACTONE[1]

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The cause of the coconut flavor in butter oil and dried whole milk previously had been associated with the presence of lactones and decalactones. In this investigation the authors report the isolation and identification of δ-decalactone from butter oil by the use of chromatograms. The coconut-like flavor is an important factor in limiting the acceptability of dried whole milk, and the development of a method for the ready detection of the compound responsible should aid in solving the problem of keeping qualities of dried milk. *Editor.*

Evidence indicating that lactones *(5)* and more particularly decalactones *(13)* may be responsible for a coconut-like flavor defect of butter oil and dry whole milk has been presented previously. The purpose of the first paper in the present series is to report the isolation and identification of the flavor compound, δ-decalactone, from butter oil, together with paper chromatographic methods for its detection. A second publication *(7)* deals with the presence of δ-decalactone in several stored dairy products. An abstract of these findings has been published *(6)*.

EXPERIMENTAL PROCEDURE

Preparation and extraction of butter oil. The butter oil was obtained from unsalted butter by agitating with equal volumes of warm water (60° C.) followed by separation in a small DeLaval cream separator. The washing and separating was repeated four times, the final product being a cloudy oil (0.6% moisture). The coconut-like character was developed in the butter oil by autoclaving under 18 lb. pressure for approximately 3 hours. Extraction of the flavor substance was started within a few days after the heat treatment. During the investigation several 19-l. batches of heat-activated butter oil were extracted with methanol in a continuous liquid-liquid extractor of conventional design. Each extraction was interrupted three times during the extraction period to remove the fatty layer that had accumulated in the solvent reservoir. After 60 hours of continuous extraction the methanol layer in the chamber was siphoned off and added to the

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methanol extract from the solvent reservoir. The fatty material that had been periodically removed from the solvent reservoir (600 ml. in all) was re-extracted with methanol for 24 hours in a small liquid-liquid extractor. The methanol extract obtained from this second extraction was added to the original methanol extract. After evaporation of the solvent, 150 ml. of material (mostly water) remained. Ethyl ether extraction of this material yielded 20 ml. of a yellow-orange oil after evaporation of the solvent from the dried ether extract. This residue had a strong coconut-like character and remained as a clear oil at room temperature.

Experiments with the methanol extract. About 1 g. of a yellowish fatty material was obtained by steam distilling the oil and extracting the distillate with ethyl ether. Although this residue was a mixture of odoriferous compounds, a distinct coconut-like character could be detected. The pot residue retained some coconut-like odor potential, indicating either that the flavor compound was not readily steam-distillable or that it was being generated during the steam distillation experiment. By utilizing a $NaHCO_3$ extraction, the steam-distillable residue was separated into acidic (0.2 g.) and neutral (0.8 g.) fractions. The odor character of the former was suggestive of the lower fatty acids, and that of the latter was described as ketonic and coconut-like. Girard's T Reagent was used to remove the carbonyl compounds from the neutral fraction. Approximately 0.4 g. of a noncarbonyl fraction was obtained, which emitted a definite δ-decalactone odor.

Despite the fact that there was not enough of the coconut-like flavor compound in the final extract to warrant further attempts at characterization, information of considerable value was obtained from this initial trial with a large batch of butter oil. The fact that the flavor compound did not react with Girard's T Reagent was considered good evidence that it was not a carbonyl compound. Moreover, if the flavor compound had been a fatty acid, then the $NaHCO_3$ separation would have so indicated. The fact that the odor character of the coconut-like fraction became more like that of δ-decalactone with each step in the isolation procedure seemed to indicate that the proposed identity of the flavor compound was correct.

Adsorption chromatography. Although the bulk of the coconut-like methanol extract from butter oil was composed of glyceride material, small amounts of carbonyl compounds and fatty acids also were present. The widely varying functional properties of these constituents suggested that adsorption chromatography might be used for removing some of them from the lactone-containing fraction. This supposition was borne out by trials conducted on butter oil that contained added δ-decalactone. Neutralized alumina was used as the adsorbent. This method proved to be a much more effective means than steam distillation for concentrating the coconut-like flavor compound. Adsorption on alumina was particularly effective in removing the free fatty acids from the lactone-containing fraction. Consequently, another 19-l. batch of butter oil was extracted with methanol and the 20-ml. volume of fatty residue obtained therefrom was chromatographed on neutralized alumina.

Neutralized alumina was prepared by the method of Reichstein and Shoppee *(14)*, and was then activated by heating in a muffle furnace at 180° C. for 12 hours. Two hundred g. of the adsorbent were slurried in petroleum ether and then packed into a 4 × 50 cm. glass tube plugged at the constricted end with glass wool. The coconut-like methanol extract was dissolved in a solvent mixture composed of 125 ml. of petroleum ether and 225 ml. of ethyl ether. This solution containing the flavor extract was applied to the column, and the developed chromatogram was eluted with various solvents. These solvents were, in order of application: *(a)* 200 ml. of ethyl ether, *(b)* 300 ml. of 10% methanol in ethyl ether, *(c)* 300 ml. of methanol, *(d)* 900 ml. of 2% HCl. The eluate was collected in 25-ml. fractions, and the solvent in each fraction was evaporated over a steam bath.

The results of this experiment may be summarized as follows. The bulk of the glyceride material was not adsorbed and was collected in the petroleum ether–ethyl ether fraction. After the solvent had been evaporated, there remained a 15-ml. volume of an essentially odorless, yellow-orange oil. No additional material was desorbed until the ether-methanol solvent appeared as eluate. This solvent combination removed from the column 2.3 g. of an orange-colored fatty substance that emitted a ketonic and coconut-like odor. Approximately 1 g. of a colorless and odorless oil was eluted by methanol. The first 20 ml. of the HCl eluate that dripped from the column emitted a strong coconut-like odor. After 100 ml. had been collected, no coconut-like odor was evident on further elution. Approximately 0.5 g. of a brown oil was obtained by ethyl ether extraction of the HCl eluate. The odor of this residue was described as "strong coconut," "butyric acid," and "like rum."

The 2.3-g. quantity of material eluted by the ether-methanol solvent combination was agitated with 20 ml. of a 5% Na_2CO_3 solution for 3 hours. After the neutral material had been removed by ether extraction, the aqueous Na_2CO_3 solution was acidified with dilute HCl. The acidified fraction was cloudy and emitted a very strong, clean δ-decalactone odor. After standing overnight the mass was extracted with ethyl ether. Two or 3 mg. of residue were obtained, the odor of which was indistinguishable from that of authentic δ-decalactone.

The 0.5 g. of brown oil recovered from the aqueous acidic eluate was dissolved in 30 ml. of petroleum ether and then shaken with 30 ml. of 2% $NaHCO_3$ solution to remove the acidic substances. Approximately 0.3 g. of a viscous brown oil was recovered from the petroleum ether layer. This residue had a strong coconut-like odor. Acidification of the $NaHCO_3$ layer followed by ethyl ether extraction yielded a butyric acid–smelling residue. The fact that the coconut-like flavor compound appeared in two different fractions indicated that some of the lactone was being strongly adsorbed as the free hydroxy fatty acid or its salt. Apparently the adsorbent retained sufficient alkalinity to saponify the lactone, or else the alumina was activated to such a high degree that the lactone was literally pulled apart and existed as the free hydroxy fatty acid. Since the principal function of the alumina chromatography is to separate the lactone from the free fatty acids, it is best to carry out the chromatography under conditions that will

result in a minimum amount of lactone hydrolysis. As will be shown, the lactone isolated from the methanol-ether eluate was relatively free of contaminants, whereas that recovered from the aqueous eluate was contaminated with other substances.

Infrared spectral analysis. Infrared spectra in the region from 2 to 15μ were secured for the flavor compound from the methanol-ether eluate and for a 1% solution of authentic δ-decalactone. For this purpose a Perkin-Elmer Model 21 Double Beam Recording Spectrophotometer with NaCl cells (0.1-mm. thickness) and CCl_4 as solvent were employed. Both spectra are reproduced in Figure 1.

The infrared spectrum of the coconut-like flavor compound is essentially superimposable upon that of a pure synthetic sample of δ-decalactone. Major absorption peaks appear in both spectra at 3.43, 5.73, 6.86, 8.11, 8.62, 9.68, and

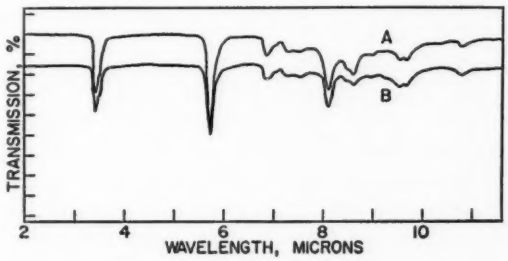

FIG. 1. Infrared spectra of δ-decalactone (A), and the coconut-like flavor compound from butter oil (B).

10.8 μ. The major absorption peak at 5.73 μ is characteristic of delta lactones *(3)*. This peak alone cannot be used as positive proof for the presence of delta lactones since chemical compounds with an ester linkage will show absorption in this region. However, the possibility that the flavor compound is a gamma lactone is definitely eliminated since gamma lactones exhibit characteristic absorption in the region of 5.62 μ rather than at 5.73 μ *(3)*. The possibility that the flavor compound might have been a closely related analog of δ-decalactone, i.e., the delta lactones of nine- or eleven-carbon hydroxy fatty acids, seems to be precluded by the paper chromatographic evidence to be presented. A spectrum also was obtained on the fraction eluted by dilute HCl. Although this spectrum showed considerable similarity to that from the authentic lactone, it was distinctly distorted in several areas, indicating that the sample was impure.

Paper chromatography. The only reported qualitative chemical color test for lactones involves the formation of a ferric ion complex with the hydroxamic acid derivative of the lactone *(2)*. A purple to red-brown color will result, depending upon the carbon chain length. A preliminary investigation of this reaction revealed that when the lactone or acid radical of the ester contains 10 carbons or less a purple color is produced. A red-purple color characterizes the compounds with 11 or 12 carbons. As the chain length increases, the color changes to a red-

brown with little color being evident with 18-carbon acid esters. Since this is a general test for carboxylic acid esters, its usefulness in detecting the presence of lactones is limited unless the substance is free of glyceride material. Moreover, even if assurances could be had that the test material was free of glycerides and simple esters, the identity of the lactone responsible for the positive test could not be determined. However, the test seemed to have definite possibilities when used in conjunction with paper chromatography. Sugar lactones have been identified by conversion to hydroxamic acid derivatives after chromatographic development *(1)*, and fatty acid mixtures have been resolved by paper chromatography of the hydroxamic acid derivatives *(15)*. During the course of this investigation two paper chromatographic methods were developed whereby δ-decalactone could be identified in extracts that contained mixtures of fatty acid esters. Since the separation of the lactones of hydroxy fatty acids containing in the neighborhood of 10 carbon atoms has not previously been published, the methods used are reported in some detail.

A. *Reagents.* The spot test reagents described by Feigl *(2)* were modified so as to be applicable as spray reagents. They were: *(a)* 10% solution of hydroxylamine · HCl in methanol; *(b)* 20% solution of KOH in methanol; *(c)* solution of equal volumes of 5% $FeCl_3$ and 5% HCl. Experience indicated that there could be considerable variation in the strength of these reagents without altering the sensitivity of the test. To react with an ester or lactone the hydroxylamine must be in an alkaline solution. This spray reagent was prepared by adding alcoholic KOH to the hydroxylamine solution until pH 12 was obtained. The crystalline salt thus precipitated was removed from the reagent by filtration.

B. *Chromatography before converting to hydroxamic acid derivatives.* One per cent solutions of the lactones in methanol were spotted on Whatman No. 1 filter paper and then the paper was fastened into the shape of a cylinder and placed in a petri dish in the bottom of an 18 × 6 in. glass cylinder. After equilibrating against a 60% methanol in water solution for 1 hour, the chromatogram was developed (ascending) by using a 60% methanol in water solution as the developing solvent. After the solvent had moved about 10 in. (4 hours required), the chromatogram was removed from the chamber, air dried, and then sprayed with the alkaline hydroxylamine solution. After the paper had dried, the acidic $FeCl_3$ spray was applied. Typical Rf values for the lactones tested appear in Table 1.

C. *Chromatography as the hydroxamic acid derivative.* The other chromatographic method involved the conversion of the lactones and esters to their hydroxamic acid derivatives followed by chromatographic separation on paper of the derivatives thus formed. By a similar method Thompson *(15)* separated mixtures of aliphatic acids containing one to nine carbon atoms. In the study herein reported the chromatograms were developed by ascending technique, the apparatus and arrangement of the chromatograms being the same as those described for the chromatography of unreacted lactones. The solvent system recommended by Thompson was modified slightly, in that acetic acid was used in place of formic acid and a slightly different ratio of solvents was used. Benzene, water,

TABLE 1

Odor and paper chromatographic behavior of several lactones and fatty acid esters

Compound	Odor	Rf values	
		Chromatographed prior to derivative formation	Chromatographed as hydroxamic acid derivative
γ-butyrolactone	faint aromatic	—	0
γ-valerolactone	faint aromatic	—	0
γ-nonalactone	sour dishrag, coconut	0.83	0.34
γ-decalactone	peach	0.75	0.54
γ-hendecalactone	licorice	0.70	0.73
γ-dodecalactone	sl. peach	0.62	0.84
δ-decalactone	coconut	0.78	0.35
δ-hendecalactone	peach, sour dishrag	0.71	0.65
butyrate	———	—	0.22
caproate	———	—	0.68
caprylate	———	—	0.92
caprate	———	—	0.95

and glacial acetic acid in a 5:5:1 volume ratio were shaken in a separatory funnel, and the aqueous phase which separated was placed in the bottom of the chamber as the equilibrating solvent. A 10% glacial acetic acid in benzene solution served as the developing solvent. The hydroxamic acid derivatives were prepared by adding approximately 5 mg. of the lactone or ester to 0.5 ml. of the alkaline hydroxylamine solution. A reaction time of 15 minutes was allowed before spotting the paper. After equilibrating for 1 hour, the developing solvent was pipetted into the petri dish. The solvent moved a distance of 10 in. in a 5-hour period. After being developed, the chromatogram was removed from the chamber, air dried, and then sprayed with the acidic $FeCl_3$ solution. In general, the principles and precautions involved in the manipulation of paper chromatograms as outlined by Lederer and Lederer *(9)* were followed. Table 1 records typical Rf values for the lactones and esters that were chromatographed. The data show that a homologous series of gamma lactones can be separated, either by chromatographing the lactones before conversion to hydroxamic acid derivatives or by chromatographing the lactone derivative directly. Table 1 reveals that the suspected coconut-like flavor compound, δ-decalactone, can be differentiated from fatty acid esters and from other delta lactones by paper chromatography. The similarity between the paper chromatographic behavior of δ-decalactone and γ-nonalactone is not a problem in this study since infrared analysis shows no trace of gamma lactones in the coconut-like flavor extract obtained from butter oil.

D. *Paper chromatography of the coconut-like flavor compound isolated from butter oil.* The coconut-like fraction obtained from the methanol–ethyl ether eluate and the fraction eluted by dilute HCl were subjected to paper chromatographic analysis. For reference purposes, butyrate, caproate, and authentic δ-decalactone hydroxamic acid derivatives were chromatographed on the same paper with the derivatives of the coconut-like flavor compound. Only δ-decalactone was chromatographed with the unknown in the chromatogram developed before conversion to the colored derivative. The preparation of derivatives and the manipulation of the chromatograms were the same as those used in obtaining

the results listed in Table 1. Reproductions of these chromatograms appear in Figure 2.

In both chromatograms the spots developed from the coconut-like extracts of butter oil appear at the same relative position on the chromatograms as does δ-decalactone. Chromatography as the hydroxamic acid derivatives shows that the spots from the coconut-like extracts cannot be confused with butyrate or caproate esters. Such esters would not be expected to be present since the steps used in isolating the flavor compound should have assured the removal of all such ester material. The possibility that the flavor compound is a lactone other than δ-decalactone or a mixture of lactones is precluded by the paper chromatographic evidence.

Control experiments. The control measures employed in this study were primarily organoleptic. Butter oil freshly prepared from sweet cream butter was

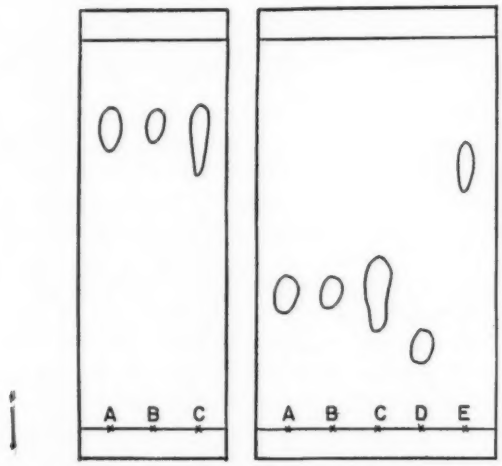

FIG. 2. Chromatograms of coconut-like flavor extracts from butter oil. Left, development before conversion to hydroxamic acid derivatives: (A) authentic δ-decalactone, (B) extract from methanol-ether eluate, (C) extract from aqueous eluate. Right, development after conversion to hydroxamic acid derivatives: (A) authentic δ-decalactone, (B) extract from methanol-ether eluate, (C) extract from HCl eluate, (D) butyrate, (E) caproate.

evaluated for flavor both as such and when emulsified in pasteurized skimmilk at a level of 4%. Such oil did not exhibit or impart the coconut-like flavor defect. However, when this butter oil was heat-activated in the manner described or was stored at room temperature for several months in the dark, it readily exhibited and imparted to skimmilk the coconut-like flavor. In addition, methanol extracts and steam distillates of fresh butter oil were prepared. These preparations were free of coconut-like odor, whereas this odor was clearly evident in the extracts and distillates from aged or activated samples of butter oil. Odor and flavor evaluation were clearly the most sensitive means of detecting the coconut-

like flavor compound in this investigation. Negative results in such evaluations were considered sufficient to preclude the necessity of additional control tests.

DISCUSSION

The identification of δ-decalactone as the coconut-like flavor compound present in heat-activated butter oil was based on the following evidence. The infrared spectrum of the coconut-like flavor compound isolated from butter oil was essentially superimposable upon the spectrum of a pure synthetic sample of δ-decalactone (Figure 1). The paper chromatographic behavior of the two compounds, both as such and as hydroxamic acid derivatives, was identical, and their odor characters were indistinguishable one from the other. Other similarities noted during the course of isolating the flavor compound can be cited. The flavor compound's behavior when chromatographed on alumina was the same as that of δ-decalactone. Neither compound reacted with Girard's T Reagent, and both were extremely sensitive to alkaline hydrolysis. As was true with δ-decalactone, the coconut-like odor reappeared when an odorless alkaline solution of unknown compound was acidified. There are many possible delta lactone isomers of δ-decalactone. That any of these isomers may be the coconut-like flavor compound is highly improbable since its odor, infrared spectral properties, and behavior by two different chromatographic procedures would have to be identical to such properties of δ-decalactone.

The principal motivating force behind this research was the problem connected with the flavor defect that forms early in the storage life of dry whole milk. The literature refers to several flavors of a nontallowy and noncaramelized type which may develop in this medium. Descriptive terms include: "heated" and "butter-toffee" *(8)*, "stale" *(16)*, "flavor not readily definable" *(10)*, "coconut-like" and "typical dry whole milk flavor" *(4, 11, 12)*. It is not clear whether different descriptive terminology is being used for the same basic off-flavor or whether entirely different flavor problems are involved. The research herein reported deals with the off-flavor described as "coconut-like." It is believed that development of this defect is the principal flavor change of a nontallowy type that occurs in dry whole milk and is, perhaps, the greatest single factor limiting the acceptability of reconstituted whole milk powder as a suitable substitute for fresh fluid milk. With δ-decalactone established as the coconut-like flavor compound present in butter oil, and with two sensitive paper chromatographic procedures developed for detecting the lactone, attempts to demonstrate the compound in dry whole milk, dried cream, and evaporated milk were facilitated *(7)*.

So far as is known, the paper chromatographic separation of closely related lactones has not previously been reported. Gamma and delta lactones of hydroxy fatty acids with carbon chain lengths in the neighborhood of ten carbon atoms are powerful flavoring agents. The paper chromatographic methods developed during the course of this investigation could be used in research dealing with synthetic or natural flavor extracts suspected of containing any one or a mixture

of these lactones. These methods certainly warrant further consideration as analytical tools.

SUMMARY

The coconut-like off-flavor compound, which develops in butter oil during storage or when butter oil has been heated, was isolated and identified as δ-decalactone (the lactone of 5-hydroxy decanoic acid). Infrared spectroscopy and paper chromatography were used in establishing the flavor compound's coidentity with δ-decalactone. Paper chromatographic methods are presented whereby a homologous series of gamma lactones from nonalactone to dodecalactone can be resolved. Evidence that a similar series of delta lactones can be separated in a like manner was obtained.

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THE COCONUT-LIKE FLAVOR DEFECT OF MILK FAT. II. DEMONSTRATION OF δ-DECALACTONE IN DRIED CREAM, DRY WHOLE MILK, AND EVAPORATED MILK[1]

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By the use of chromatograms the presence of δ-decalactone in dried cream, dried whole milk, and evaporated milk was determined. This study emphasizes the need for further research on the factors leading to the formation of various unreported trace elements that may be present in or associated with the lipid fraction of milk and its products. *Editor.*

The coconut-like off-flavor is a major storage defect of a number of fat-containing dairy products. The preceding paper dealt with isolation of δ-decalactone, the off-flavor compound, from butter oil; and two paper chromatographic methods were described by which this compound could be identified *(1)*. The purpose of this paper is to present evidence which establishes the presence of δ-decalactone in dried cream, dry whole milk, and evaporated milk. The significance of the presence of this flavor compound is discussed.

EXPERIMENTAL PROCEDURE

Extraction of the Flavor Compound.

A. *Dried cream.* A commercial sample of dried cream, exhibiting a strong coconut-like flavor, was available in the laboratory. This product had been manufactured in 1945 and had been sealed under vacuum and stored at room temperature for 10 years. The flavor stability of this product deserves special note. The reconstituted cream was remarkably free of any of the oily, tallowy character associated with the normal oxidative deterioration of dried milk products. According to the label on the can, the powder contained no preservatives or adulterants. The flavor of the reconstituted cream was described as "strong-coconut" and "like dry whole milk." A coconut-like concentrate was obtained by separating the fat from the dried product and then extracting the fat fraction in the same manner as that used in isolating δ-decalactone from butter oil *(1)*. A quantitative recovery of fat from dried cream was obtained by Soxhlet type extrac-

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tion with ethyl ether as the extracting solvent. The 680-g. quantity of butter oil recovered from 1 kg. of dried cream was extracted continuously with methanol in a 1-l. liquid-liquid type extractor. After 40 hours the extraction was stopped and the solvent reservoir contents were transferred to a separatory funnel. The 75 ml. of fatty material that separated were discarded, and the methanol extract was reduced to about 20 ml. of fatty residue by heating over a steam bath. The odor of the residue was described as coconut-like and rancid, somewhat like butyric acid.

In order to remove fatty acids and other impurities, the coconut-like concentrate was chromatographed on neutral alumina that had been activated by heating at 150° C. for 4 hours. The object of the milder activation was to avoid conditions that might cause hydrolysis of the lactone on the column. Such a situation occurred during the chromatographing of the coconut-like concentrate from butter oil *(1)*. Sixty grams of adsorbent (slurried in petroleum ether) were packed into a 2 × 17 cm. glass column, and the 20-ml. quantity of residue was dissolved in 150 ml. of petroleum ether and then applied to the column. The column was eluted with 100 ml. of petroleum ether, followed in order by 100-ml. quantities of ethyl ether, 20% solution of methanol in ethyl ether, and methanol. After the above treatment, the adsorbent was extruded from the column and mixed with 200 ml. of 2% HCl. The acid solution was decanted and extracted with ethyl ether. The characteristics of the various fractions are summarized as follows:

Eluted by	*Properties*
Pet. ether–ethyl ether	17 ml. of yellow, odorless oil
Methanol–ethyl ether	2 ml. of coconut-like yellow liquid
Methanol	2 ml. of solid fatty acid material with crotonic acid smell
Dilute HCl	Few mg. of material with odor of butyric and crotonic acids

All the coconut-like character was concentrated in the fraction eluted by the methanol-ether solvent. This fraction was agitated with dilute Na_2CO_3 solution for 4 hours. The neutral material was removed by ethyl ether extraction and then the aqueous solution was acidified. Ethyl ether extraction yielded about 0.1 g. of a yellow coconut-smelling oil.

B. *Dry whole milk.* Whitney and Tracy *(4)* obtained a good recovery of butter oil from dry whole milk by hydrating the powder to a moisture level of at least 8% followed by ethyl ether extraction in a Soxhlet type apparatus. In the study herein reported, 2½-lb. batches of dry whole milk were hydrated in a 12 × 24 in. closed glass cylinder that contained a 1-l. beaker filled with water. After a 24-hour period the powder was sifted through a flour sifter and then equilibrated for an additional 24 hours in the chamber. A moisture level of about 10% was obtained in this manner. A total of 10 lb. of a commercial brand of vacuum-packed dry whole milk that exhibited the coconut-like flavor and odor that typify such a product was hydrated. The fat was extracted from 1.2-kg. batches of the hydrated powder by utilizing a large Soxhlet-type apparatus with

ethyl ether as the extracting solvent. The 1.3-kg. quantity of fat recovered from 10 lb. of dry whole milk was then extracted continuously with methanol in a liquid-liquid extractor for 48 hours. Fifteen ml. of residue with a coconut-like odor was obtained from the methanol layer of the solvent reservoir.

The coconut-like residue was dissolved in 100 ml. of ethyl ether and chromatographed on a column that was prepared by mixing 100 g. of neutralized alumina in petroleum ether followed by packing in a 15 × 1 in. glass tube. The column was eluted with 100 ml. of ethyl ether, then 100 ml. of a 10% solution of methanol in ethyl ether, and finally 100 ml. of a 2% HCl solution. As in the extract from dried cream, the coconut-like character of the dry whole milk extract was concentrated in the methanol–ethyl ether eluate. This 2-ml. fraction was subjected to a Na_2CO_3 extraction that was identical with that described above.

C. *Evaporated milk.* The typical flavor of evaporated milk appears to be a composite of different flavors. Patton *(3)* has classified these flavor components as caramelized, hydrogen sulfide, hydrolytically rancid, and lactone. In an attempt to determine if lactones contribute to the flavor, a sample of evaporated milk was extracted and examined paper chromatographically for the presence of δ-decalactone. A coconut-like flavor fraction from evaporated milk was obtained by the following procedure. The contents of four cans of a representative commercial evaporated milk were extracted twice with 3-l. portions of acetone. Most of the acetone was volatilized over a steam bath. The aqueous solution was then cooled overnight in a refrigerator, decanted, filtered, and extracted continuously with ethyl ether for 42 hours. The solvent was removed from the extract leaving approximately 4 ml. of residue. This residue was extracted three times with small portions of petroleum ether. Two ml. of fatty material having a coconut-like odor remained after evaporation of the solvent. Sodium carbonate extraction of this material yielded a few milligrams of residue with the coconut-like odor.

Paper chromatography. The coconut-like flavor extracts obtained from dried cream, dry whole milk, and evaporated milk were subjected to paper chromatographic development both before and after conversion to hydroxamic acid derivatives. For reference purposes, butyrate, caproate, and δ-decalactone hydroxamic acid derivatives were chromatographed on the same paper with the derivatives of the coconut-like flavor compound. Only δ-decalactone was chromatographed with the unknowns in the chromatograms developed before conversion to the colored derivatives. The preceding paper presents these methods in detail *(1)*. The paper chromatographic behavior of the coconut-like extracts from dried cream, dry whole milk, and evaporated milk were the same both as to the number of spots developed and their relative positions on the chromatograms. For the sake of brevity, Figure 1 is presented as closely representing chromatograms obtained for all three flavor extracts.

RESULTS AND DISCUSSION

Two different paper chromatographic procedures have been used to demonstrate the presence of δ-decalactone (the lactone of 5-hydroxy decanoic acid) in coconut-like flavor extracts obtained from dried cream, dry whole milk, and

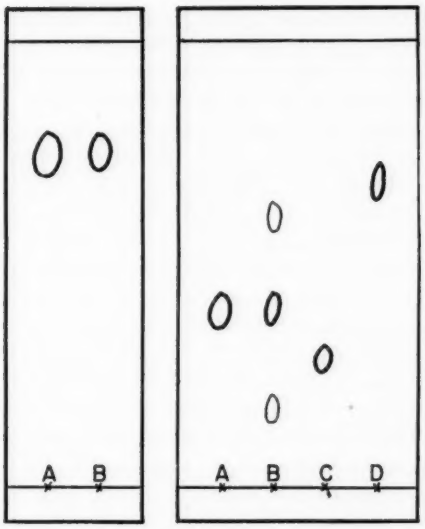

FIG. 1. Chromatograms of coconut-like flavor extract from dried cream.* Left—development before conversion to hydroxamic acid derivatives: (A) flavor extracts, (B) authentic δ-decalactone. Right—development after conversion to hydroxamic acid derivatives: (A) δ-decalactone, (B) flavor extract, (C) butyrate, (D) caproate.

* Similar chromatograms were obtained for the coconut-like extracts from dry whole milk and evaporated milk.

evaporated milk. That the spots which appear at the same relative positions as δ-decalactone could be caused by compounds other than this lactone is precluded by the infrared and paper chromatographic evidence presented in the preceding paper *(1)*.

Chromatographing the coconut-like flavor extracts as the hydroxamic acid derivatives revealed the presence of two other components which give a colored derivative when sprayed with $FeCl_3$ solution. This was surprising in view of the fact that only a single component was present in the coconut-like flavor extract obtained from butter oil *(1)*. Whether these spots were caused by lactones other than δ-decalactone cannot be determined at this time. The color intensity and spot size for each of these components were of a much smaller magnitude than those of the spot corresponding to δ-decalactone. It should be noted that the area around these spots showed a strong fluorescence under ultraviolet light before spraying with $FeCl_3$. The possibility that the compounds responsible for these spots may have been extracted from the nonfat portions of the powders and the evaporated milk cannot be precluded. The fact that only single spots appeared on the chromatograms developed before conversion to hydroxamic acid derivatives might be accounted for by the fact that the spots developed by this technique are not as distinct as are those developed by chromatographing the hydroxamic

acid derivatives. Consequently, the two components responsible for the additional spots on the chromatogram developed after conversion to hydroxamic acid derivatives might not have been present in sufficient amounts to be detected on the chromatograms developed prior to derivative formation.

One can only speculate as to how δ-decalactone, the coconut-like flavor compound, is formed. One plausible origin of the lactone which has been considered is 9-decenoic acid, a component of milk fat glycerides. Synthesis of this acid and investigation of its tendency to form decalactones under appropriate conditions has eliminated it as the apparent precursor of the coconut-like flavor *(2)*. Two consistently made observations pertaining to this problem are: The flavor defect is heat generated and it always appears early in the storage life of the dairy product. The latter observation suggests that the flavor formation mechanism is relatively simple and does not involve any drastic degradation of the fat. The fact that δ-decalactone was demonstrated as being present in evaporated milk can be considered good additional evidence that the flavor formation mechanism is nonoxidative in character. Evaporated milk, which contains a wealth of reducing substances, would not be expected to be a good medium for lipid oxidation. Concerning the flavor-generating effect of heat, it can be expected that δ-decalactone will contribute to the composite flavor character of any stored fat-containing dairy product that is exposed to high processing temperatures. Thus, the scope of this flavor problem is much greater than is generally realized.

The presence of a coconut-like flavor in dry whole milk renders the reconstituted product readily distinguishable flavor-wise from fresh fluid milk. Consequently, liberal use has been made of the term "coconut-like off-flavor" in connection with products intended for use as substitutes for fresh fluid milk. The presence of δ-decalactone in milk products manufactured for nonbeverage purposes may actually be desired. For instance, the pleasing flavor and aroma imparted by butter in baked and fried foods is due, at least in part, to δ-decalactone. This savory character is not obtained when vegetable shortenings are used because the coconut-like flavor and aroma cannot be induced in these fats.

During the course of these investigations the authors have become increasingly impressed by the chemical complexity of milk fat and by our lack of knowledge concerning its composition, particularly in regard to trace constituents. Although these trace constituents may not contribute significantly to the over-all chemical and physical properties of the fat, from a flavor standpoint any one of them could be of great importance. Odors described as phenolic, cheesy, and rum-like have been consistently noted in certain fractions obtained during the extraction of δ-decalactone from butter oil and other fat-containing dairy products. Extensive research in this field should reveal the presence of many as yet unidentified compounds. Available evidence suggests that the precursor of δ-decalactone is one of these unidentified compounds.

SUMMARY AND CONCLUSIONS

Coconut-like flavor extracts were obtained from dried cream, dry whole milk, and evaporated milk. The presence of δ-decalactone in these flavor extracts was

established by paper chromatography, and the characteristic coconut-like flavor defect of these products is attributed to this lactone.

ACKNOWLEDGMENTS

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PRESERVING THE ORIGINAL ACTIVITY OF FRESH MILK LIPASE[1]

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To properly study lipase activity in milk it is desirable to control the loss in activity of the enzyme that occurs during the first hours of cold storage. This the authors have succeeded in doing by deaerating the milk by nitrogen ebullition. *Editor.*

A rapid decrease in lipase activity during the first hours of cold storage presents a problem to the investigator interested in estimating the lipase content of fresh milk. Peterson *et al. (6)* observed this phenomenon but also found little additional decrease after 12 hours of aging at 0° C. They followed the practice of holding all samples at this temperature for a period of 10 to 15 hours prior to making their lipase determinations. This practice provided samples in which the lipase activity remained reasonably constant. The values they reported for the milk of individual cows, however, do not necessarily reflect the lipase activity of the freshly drawn product. The writers *(2)* became acutely aware of this problem in connection with the development of a photometric method of estimating milk lipase.[4] They repeatedly observed small, but significant, decreases, which were traced to a few minutes difference in the age of the milk. In one experiment involving seven comparisons between fresh and aged (30 hours at 0° to 4° C.) milk, an average 19% loss in activity was noted.

Davies *(1)* reported that traces of heavy metals, particularly copper, inhibited the action of lipase in unpasteurized sweet cream butter. He suggested that oxidation of the enzyme was partly responsible for the decrease in lipase activity. Krukovsky and Sharp *(4)* later confirmed the work of Davies. They concluded that dissolved oxygen alone could be responsible for some lipase inactivation. These workers deaerated their milk samples by boiling them under reduced pressure. Apparently the oxygen was almost completely removed by this procedure. Hlynka and Hood *(3)* deaerated milk samples by ebullition with nitrogen and confirmed the findings of Krukovsky and Sharp. The work of these three groups of investigators indicated that the decreases in lipase activity during cold storage

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[1] Published with the approval of the Director of the North Dakota Agricultural Experiment Station as a partial report on Bankhead Jones Project 39 "Estimation and Properties of Natural Milk Lipase(s)."

[2] Present address: Washington State Agricultural Experiment Station, Pullman.

[3] Retired.

[4] Use of the term "lipase" in this report does not indicate the authors believe there is only one enzyme present nor does it necessarily mean that the enzyme is a true lipase. Its use is dictated by common practice.

(2, 6) were due to the presence of air or oxygen and suggested a method by which the original lipase activity of fresh milk could be preserved. The work reported below was undertaken to determine whether deaeration by nitrogen ebullition could be used as a practical method of preserving the activity of milk lipase over a 30-hour holding period.

EXPERIMENTAL PROCEDURE

Twenty-five duplicate samples, of approximately 200 ml. each, were collected from the morning milk of individual cows in the college herd. These samples were drawn from the stainless steel weigh bucket of a pipeline milker, after thorough air mixing, in the manner described by Montgomery *et al. (5)*. They were collected in 500-ml., amber Pyrex bottles. These bottles were fitted with rubber stoppers carrying inlet and outlet glass tubes. The inlet tube extended to within $\frac{1}{4}$-in. of the bottom of the bottle, whereas the outlet tube barely passed through the stopper. A short section of rubber tubing with a screw clamp was attached to each inlet and outlet tube. This arrangement made it possible to bubble nitrogen through a milk sample for the desired length of time, as described below, and then, by closing the screw clamps, to seal the sample in an atmosphere of nitrogen.

A six-burner, micro-Kjeldahl digestion apparatus was converted to serve as a manifold for distribution and control of nitrogen to the samples. This was accomplished by covering the air ports of the burners with tight-fitting sections of Tygon tubing and connecting the stack of each burner to a piece of glass tubing by means of rubber tubing and a screw clamp. Commercial drum nitrogen was led to the gas inlet of this converted burner through a needle valve and a section of rubber tubing. This apparatus made it possible to bubble nitrogen through as many as six samples of milk at one time. It was also possible, by manipulation of the needle valve and burner valves, to adjust the flow of nitrogen through each sample to a rate of about five bubbles per second. A constant pressure-reducing valve on the nitrogen drum would have been desirable but was not available at the time this work was undertaken.

Immediately upon collection of a pair of duplicate samples, they were placed in a bath of ice water, connected to the manifold, and nitrogen was bubbled through each at a rate of about five bubbles per second for a period of at least 20 minutes. At the end of the ebullition period the samples were sealed in an atmosphere of nitrogen by closing the screw clamps. Three pairs of samples were collected in this manner each time samples were taken. These were brought to the laboratory, in ice water, as soon as the third pair of samples had received their nitrogen treatment.

Lipase determinations were commenced on one sample from each pair of duplicates immediately upon receipt in the laboratory. This sample is referred to as the fresh sample. The other sample of each pair was tested for lipase after storage at 0° to 4° C. for approximately 30 hours. This sample is referred to as the aged sample. Lipase determinations were made in duplicate by the method of

Forster *et al. (2)*, with the butyryl ester of 2-naphthol-6-sulfonic acid as substrate.

The data obtained in this work, together with the essentials of the statistical treatment, are summarized in Table 1. It will be noted that the aged samples showed slightly less substrate hydrolysis, namely 0.039 μM. This difference was not statistically significant at the 5% level.

Table 2 shows the frequency distribution of the individual differences between pairs of replicate samples. Plus and minus signs are used to indicate that the aged sample was higher or lower, respectively, than its corresponding fresh sample. Individual differences between pairs of samples ranged from +0.625 to

TABLE 1

Influence of deaeration by N_2 ebullition on lipase activity after 30 hours storage at 0° to 4° C.

No. of pairs	Mean μM substrate hydrolyzed			Variance	F	5% pt. of F.
	Fresh	Aged	Diff.			
25	3.940	3.901	0.039	0.0506	2.46	4.03

TABLE 2

Frequency distribution of differences[a] between fresh and aged samples

Class limits[b]	Frequency
−0.201 or more	6
−0.200 to +0.200	16
+0.201 or more	3

[a] Differences are in μM of substrate hydrolyzed.
[b] Minus sign indicates aged sample was lower than fresh, and plus sign indicates the reverse.

−0.545 μM of substrate hydrolyzed. The aged sample was higher in 12 instances and lower in 13 than the corresponding fresh sample. It can be noted from Table 2, however, that in 16 (64%) of the comparisons the differences fell within the range ± 0.200 μM. The differences exceeded ± 0.400 μM in only six comparisons.

One other observation with respect to these data should be made. Hydrolysis of substrate by the fresh milk samples (mean of duplicates) ranged from 2.237 to 6.67 μM, whereas the aged milk samples ranged from 2.21 to 6.81 μM. In terms of lipase units per milliliter of milk, as defined by Forster *et al. (2)*, these ranges would be 4.47 to 13.34 units for the fresh samples. These values are reported because they show the range in lipase content of milk from different cows, as measured by the method used in this study. It should be emphasized, however, that the values obtained do not necessarily reflect the rate at which lipolysis of milk fat will take place nor the rate at which a rancid flavor might develop in the milk samples studied.

DISCUSSION

The lipase content of milk from the individual cow and the factors which influence this have not been thoroughly studied. A good deal of information is

available on the rate of lipolysis in cow's milk, but this work has involved use of the fat naturally present in milk as the substrate. Under such conditions the methods used do not necessarily measure enzyme concentration. Factors such as degree of subdivision of the fat particles, availability of fat surfaces to the enzyme, substrate activation, pH and salt concentrations all have their influence on the rate of lipolysis. These factors and others must be held constant if the values obtained are to reflect enzyme concentration only. When a method is used for lipase estimation which controls these factors *(2, 6)*, it soon becomes apparent that this enzyme, or a portion of it, at least, is not stable. A rapid decrease in lipase activity occurs during the first few hours of storage. This decrease may account for an average loss in activity approaching 19%. As would be expected, individual samples may show considerably more or less loss in activity.

The authors believed that it would be desirable, if not essential, to find some means of preventing this loss in activity. Such a method should be available before attempting to study the factors influencing the lipase content of milk from the individual cow. The method described above, namely, deaeration by nitrogen ebullition, is both simple and inexpensive. It also appears to be reasonably effective. The 25 milk samples studied showed only a slight average decrease in lipase content after 30 hours of cold storage. Analysis of variance indicated this decrease could be accounted for by chance and, therefore, was not necessarily due to the aging.

Three samples, however, showed substantial increases in lipase after the storage period and six showed excessive decreases. This experiment was not designed to determine whether such behavior was characteristic for the milk of certain cows or whether these excessive differences were merely chance occurrences. This is a field worthy of additional study.

SUMMARY

A method of deaerating milk samples by nitrogen ebullition is described. Twenty-five duplicate, individual cow milk samples have been deaerated by the method and lipase activity has been determined when fresh and after aging for 30 hours at 0° to 4° C. Twelve aged samples showed more, and 13 less, activity than their corresponding fresh samples. The mean activity of the fresh samples was 3.940 μM of substrate hydrolyzed, and that of the aged samples, 3.901 μM. The difference (0.039 μM) was not statistically significant.

It is concluded that deaeration by nitrogen ebullition can serve as a useful means of preserving the lipase activity of fresh milk.

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LEUCINE METABOLISM OF *STREPTOCOCCUS LACTIS* VAR. *MALTIGENES*.[1] II. TRANSAMINASE AND DECARBOXYLASE ACTIVITY OF ACETONE POWDERS

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The cause of the malt-like flavor and aroma in milk cultures is 3-methylbutanal, which originates from leucine. The authors have studied the physiological characteristics of the reaction involved in establishing the metabolic pathway by which leucine is degraded to 3-methylbutanal by cultures of Streptococcus lactis var. maltigenes. *Editor.*

The precursor of 3-methylbutanal, the compound responsible for the malt-like aroma and flavor of milk cultures of *Streptococcus lactis* var. *maltigenes*, has been shown to be leucine *(4)*. Resting cells of the organism are able to convert α-ketoisocaproic acid to both 3-methylbutanal and leucine *(6)*.

The present work was undertaken to demonstrate the presence of active leucine-glutamic transaminase in acetone powders of *S. lactis* and its malty variant, and to elucidate the α-ketoisocaproic decarboxylative mechanism of *S. lactis* var. *maltigenes* thereby establishing a metabolic pathway by which leucine is degraded to 3-methylbutanal.

EXPERIMENTAL PROCEDURE

Preparation of acetone powders. Packed washed cells of each organism were collected as described previously *(6)* and suspended in 15-25 ml. of cold (4° C.) distilled water, and 150-200 ml. of cold (–10° C.) acetone was added *(1)*. The suspensions were shaken vigorously and quickly 25-30 times and then centrifuged at –2° C. at 2,200 r.p.m. for approximately 45 minutes. The packed cells were transferred quickly to chilled weighed petri dishes, then placed in a chilled desiccator, and dried under vacuum over H_2SO_4, and finally over P_2O_5 at 4° C. After drying (24-48 hours), the residues were ground in a chilled mortar, weighed, and stored in air-tight containers at –10° C. The yield from 6-10 ml. of packed cells was 1.0-1.5 g. of dried powder.

Dialysis procedure. For the manometric studies dialyzed powders were employed. The powders were taken up in 15 ml. of cold 0.033 *M* phosphate buffer at pH 4.6; the suspensions were sealed in cellophane tubing and suspended in

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[1] This paper was prepared from data presented in a thesis by the senior author in partial fulfillment of requirements for the degree of Doctor of Philosophy at the University of Connecticut.

chilled distilled water (4° C.) in 500-ml. cylinders. From 5 to 7 l. of chilled distilled water was allowed to flow up and around the dialyzing tubes over a period of 48 hours. Suspensions dialyzed in this manner were placed in chilled petri dishes and dried in the manner described previously.

Action of acetone powders on leucine in the presence of α-ketoglutaric acid at pH 8.4 and 4.6. Ten-ml. suspensions of the powders (0.1 g.) made up in either Tris[2] at pH 8.4 or 0.033 *M* phosphate buffer at pH 4.6 were added to each of the following: 15 ml. of buffer containing 10 mg. L-leucine, 5 mg. α-ketoglutaric acid, and 0.5 mg. pyridoxal phosphate adjusted to pH 8.4 or 4.6 and to controls containing 0.5 mg. pyridoxal phosphate and 5 mg. α-ketoglutaric acid in 15 ml. of buffer adjusted to pH of 8.4 and 4.6. The mixtures were shaken well and incubated for 3 hours at 37° C.

After incubation the mixtures were deproteinized by the addition of 5 ml. of fresh tungstic acid solution containing water, 10% sodium tungstate, and 2/3 *N* sulfuric acid (60:20:20 by volume). The mixtures were centrifuged, and the clear supernatant solutions were analyzed chromatographically for amino acids and acid carbonyl compounds by methods described previously *(6)*.

Action of acetone powders on α-ketoisocaproic acid at pH 4.6. Ten-ml. suspensions (0.1 g. powder) of each organism made up in pH 4.6 phosphate buffer were added to: 15 ml. of buffer containing 0.5 mg. pyridoxal phosphate and 5 mg. α-ketoisocaproic acid and to controls containing no keto acid. After thorough shaking, the mixtures were incubated for 3 hours at 37° C. After incubation the mixtures were deproteinized with tungstic acid and the protein-free solutions were analyzed for neutral carbonyl compounds by the method described previously *(6)*.

Manometric measurement of carbon dioxide evolution. Manometric experiments were designed to demonstrate the presence or absence of active α-ketoisocaproic acid decarboxylase in *S. lactis* var. *maltigenes* and *S. lactis* acetone powders. Carbon dioxide liberation was determined by the procedure described by Umbreit *et al. (8)*, and the volume of carbon dioxide liberated was calculated by the direct method.

To the main compartments of the reaction flasks were added 0.2 ml. of pyridoxal phosphate solution (100 γ), 0.3 ml. phosphate buffer at pH 4.6, 1 ml. buffer solution containing 1 μ*M* of thiaminpyrophosphate, 1 μ*M* of lipoic acid and a trace of magnesium sulfate, and 1 ml. of buffered acetone powder suspension (10 mg. powder). The side arm contained 0.5 ml. buffered α-ketoisocaproic acid solution (1 mg.), and the center well contained 0.2 ml. of either 20% KOH or buffer and a small folded strip of filter paper. The side arm of each endogenous flask contained 0.5 ml. buffer in place of the keto acid, and the main compartment of the substrate control flask contained 1 ml. of buffer in place of the acetone powder suspension. The water bath temperature was held at 30° C., and all flasks were equilibrated for 30 minutes with the stopcocks open before the side arm contents were tipped into the main compartments of the reaction flasks. The changes in

[2] 2-amino-2-(hydroxymethyl)-1,3-propanediol.

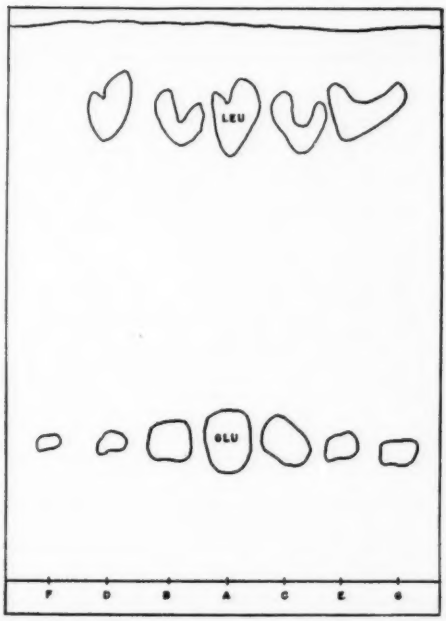

FIG. 1. Chromatogram of L-glutamic acid and L-leucine *(A)*; and of glutamic acid formed during incubation of acetone powders of *S. lactis* var. *maltigenes* and *S. lactis* with L-leucine in the presence of α-ketoglutaric acid at pH 8.4 *(B)* and *(C)*, and at pH 4.6 *(D)* and *(E)*, and with no leucine added at pH 8.4 *(F)* and *(G)*. (0.1 g. acetone powder suspended in 25 ml. of buffer containing 0.5 mg. pyridoxal phosphate, 10 mg. L-leucine, and 5 mg. of α-ketoglutaric acid.)

gaseous pressure were observed over a period of 3 hours. At the completion of the manometric experiment the reaction mixtures were deproteinized and analyzed for both acid and neutral carbonyl compounds *(6)*.

RESULTS

Acetone powders of *S. lactis* and *S. lactis* var. *maltigenes* possess leucine-glutamic transaminase systems active at pH 8.4, as demonstrated in Figures 1 and 2 by the appearance, respectively, of both glutamic acid and α-ketoisocaproic acid in *B* and *C* of Figure 1 and *D* and *E* of Figure 2. These are chromatograms of amino acids and the 2,4-dinitrophenylhydrazones of the keto acids involved when powder suspensions of the two organisms were incubated with leucine and α-ketoglutaric acid at pH 8.4. The disappearance of the latter in *D* and *E* of Figure 2 over the amount present in the controls *A* and *I* may be explained by glutamic acid formation as shown in *B* and *C* of Figure 1.

At pH 4.6 α-ketoisocaproic acid was formed from leucine by the acetone powders of both organisms, as is demonstrated by the presence of the α-ketoisocaproic acid derivative spots in *F* and *G* of Figure 2. This indicates a definite

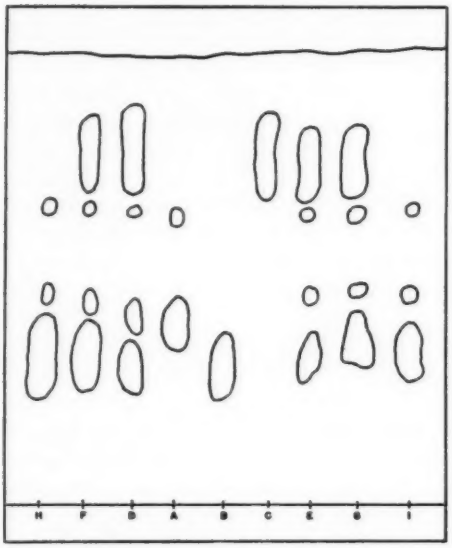

FIG. 2. Chromatogram of 2,4-dinitrophenylhydrazones of pyruvic acid *(A)*, α-ketoglutaric acid *(B)*, and α-ketoisocaproic acid *(C)*; and of acid carbonyl compounds formed during incubation of acetone powders of *S. lactis* var. *maltigenes* and *S. lactis* with L-leucine in the presence of α-ketoglutaric acid at pH 8.4 *(D)* and *(E)*, and at pH 4.6 *(F)* and *(G)*, and with no leucine added at pH 8.4 *(H)* and *(I)*. (0.1 g. acetone powder suspended in 25 ml. of buffer containing 0.5 mg. pyridoxal phosphate, 10 mg. L-leucine, and 5 mg. α-ketoglutaric acid.)

removal of the amino group from leucine, but the lack of concurrent increase in glutamic acid as evident in *D* and *E* over that shown in the controls, *F* and *G* of Figure 1, suggests that the amino group was not transferred to α-ketoglutaric acid at this pH.

The formation of 3-methylbutanal from α-ketoisocaproic acid by *S. lactis* var. *maltigenes* powder is shown in *D* of Figure 3. This is a chromatogram of the 2,4-dinitrophenylhydrazones of the neutral carbonyl compounds formed when undialyzed powders of both organisms were incubated with α-ketoisocaproic acid and pyridoxal phosphate at pH 4.6. No 3-methylbutanal was formed by the action of *S. lactis* powders on the keto acid as shown in *E* of Figure 3 nor during incubation of controls in which no substrate was added to the powder suspensions, as shown in *F* and *G*.

In preliminary manometric experiments with pyridoxal phosphate as the only added cofactor no decarboxylase activity was observed when dialyzed powder of *S. lactis* var. *maltigenes* was added to α-ketoisocaproic acid. Figure 4 indicates the microliters of carbon dioxide evolved during the course of a 3-hour incubation period at 30° C. when dialyzed acetone powders of the two organisms were allowed to react with α-ketoisocaproic acid in the presence of pyridoxal phosphate, lipoic acid, thiaminpyrophosphate and Mg^{++} at pH 4.6, the endogenous and sub-

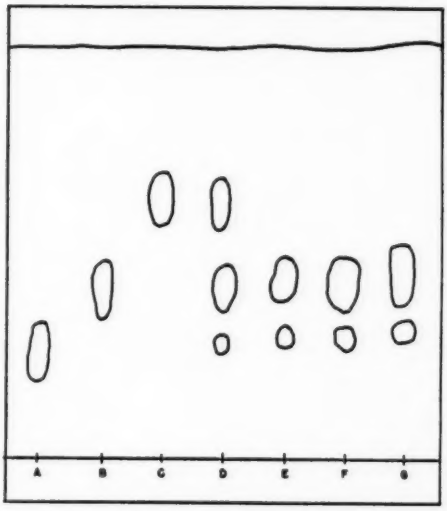

FIG. 3. Chromatogram of 2,4-dinitrophenylhydrazones of acetaldehyde *(A)*, acetone *(B)*, and 3-methylbutanal *(C)*; and of neutral carbonyl compounds formed during incubation of acetone powders of *S. lactis* var. *maltigenes* and *S. lactis* with α-ketoisocaproic acid at pH 4.6 *(D)* and *(E)*, and with no substrate added *(F)* and *G*. (0.1 g. acetone powder suspended in 25 ml. of buffer containing 0.5 mg. pyridoxal phosphate and 5 mg. α-ketoisocaproic acid.)

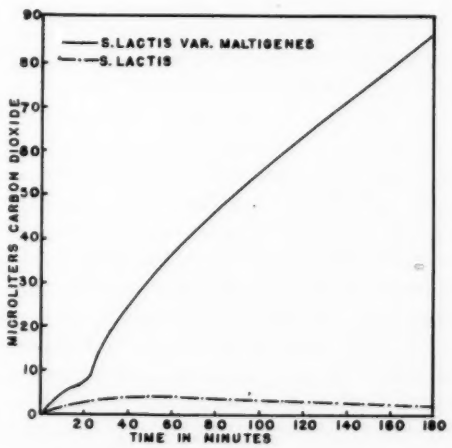

FIG. 4. Carbon dioxide evolved from action of 10 mg. acetone powders of *S. lactis* var. *maltigenes* and *S. lactis* on 1 mg. α-ketoisocaproic acid in the presence of 100 γ pyridoxal phosphate, 1 μ*M* thiaminpyrophosphate, 1 μ*M* lipoic acid, and a trace of magnesium sulfate at pH 4.6 during a 3-hour incubation period at 30° C. (Corrected for endogenous and substrate carbon dioxide.)

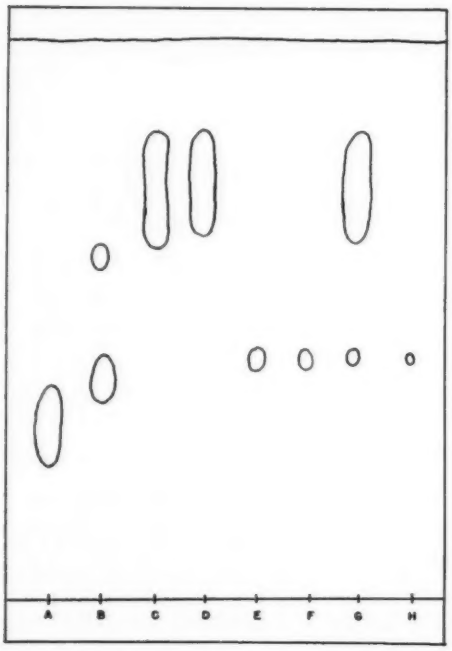

FIG. 5. Chromatogram of 2,4-dinitrophenylhydrazones of α-ketoglutaric acid *(A)*, pyruvic acid *(B)*, and α-ketoisocaproic acid *(C)*; and of acid carbonyl compounds formed during manometric determination of carbon dioxide liberated by action of acetone powders of *S. lactis* var. *maltigenes* and *S. lactis* on α-ketoisocaproic acid at pH 4.6 *(E)* and *(G)*, and in the respective endogenous controls *(F, H)*, and substrate control *(D)*.

strate corrections having been made. The microliters of CO_2 evolved by the endogenous controls of *S. lactis* var. *maltigenes* and *S. lactis* were, respectively, after 5 minutes incubation, 3.9 and 3.6, and after 3 hours incubation, 23.6 and 15. The CO_2 evolved from the substrate control was considered negligible. Oxygen uptake was not observed during the action of either cell preparation on the substrate. The decarboxylative mechanism involved in the liberation of carbon dioxide by *S. lactis* var. *maltigenes* is elucidated in Figures 5 and 6, which are chromatograms of the derivatives of the acid and neutral carbonyl compounds present in the Warburg flasks at the completion of the manometric experiment. The degradation of α-ketoisocaproic acid is evidenced by its disappearance in *E* of Figure 5 and the appearance of 3-methylbutanal in *E* of Figure 6. The negligible liberation of carbon dioxide by the action of the *S. lactis* powder suspension on α-ketoisocaproic acid and the lack of any conversion of the keto acid to 3-methylbutanal as evidenced in *G* of Figures 5 and 6 indicate the absence of active keto acid decarboxylase in this organism.

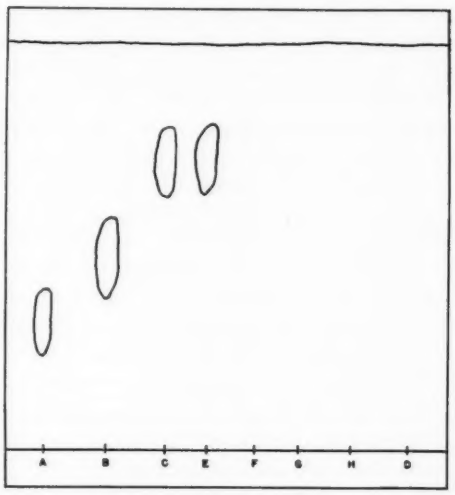

FIG. 6. Chromatogram of 2,4-dinitrophenylhydrazones of acetaldehyde *(A)*, acetone *(B)*, and 3-methylbutanal *(C)*; and of neutral carbonyl compounds formed during manometric determination of carbon dioxide liberated by action of acetone powders of *S. lactis* var. *maltigenes* and *S. lactis* on α-ketoisocaproic acid at pH 4.6 *(E)* and *(G)*, and in the respective endogenous controls *(F, H)*, and substrate control *(D)*.

DISCUSSION

The enzyme systems active in bacterial acetone powders are reacting outside their normal environment. This must be considered when interpretations are placed upon the results of the activities of these systems. Perhaps the pH may vary, depending on the location of the enzymatic action within living cells of *S. lactis* and *S. lactis* var. *maltigenes*, or the pH within the cell may vary from time to time, depending on its age, nutritional environment, etc. The fact that the acetone powders of these organisms were able to effect the removal of the amino group from leucine but were apparently unable to transfer it to α-ketoglutaric acid at pH 4.6 may not be pertinent to the behavior of this enzyme system when functioning within the living cell.

Pyridoxal phosphate is recognized as a functioning coenzyme in enzymatic transamination. Cells of *S. lactis* and *S. lactis* var. *maltigenes* are able to synthesize pyridoxal phosphate, as reported earlier *(6)*. Both dialyzed and undialyzed powders were used in the transamination experiments involving *S. lactis* var. *maltigenes*. The addition of pyridoxal phosphate had no marked effect when undialyzed powders were used but was thought to accelerate to a slight extent the dialyzed powder reactions. Therefore, pyridoxal was added routinely in all acetone powder experiments. The cells from which the powders were prepared were grown on a pyridoxal-rich medium with the exception of the powders used in the manometric experiments.

The decarboxylation of amino acids to amines by many bacteria is the result of a pyridoxal phosphate-linked enzyme system, according to Gale *(2)*. Oxidative decarboxylation, such as that of pyruvic acid or α-ketoglutaric acid by enzyme preparations of ***Escherichia coli*** to form acetyl CoA or succinyl CoA, requires addition of lipothiamidepyrophosphate in which α-lipoic acid and thiaminpyrophosphate are joined by an amide bond *(8)*. Baker's yeast, according to Green *et al. (3)* and Long and Peters *(5)*, possesses a keto acid decarboxylase system which reacts with pyruvic, α-ketoglutaric, oxalacetic, α-ketoisovaleric, and α-ketoisocaproic acids. The carboxylase isolated from yeast was a thiaminpyrophospate-magnesium-protein. The enzyme did not dissociate at pH 6 but was dissociated above pH 8. The decarboxylating system of *S. lactis* var. *maltigenes* apparently is related to yeast carboxylase. Its activity presumedly does not involve the oxidative decarboxylation system active in *E. coli*, in which lipoic acid is a co-factor *(7)*, as judged by absence of oxygen uptake in the manometric experiments.

The results of the experiments demonstrating the removal of the amino group from leucine with the resulting formation of α-ketoisocaproic acid by both organisms, the decarboxylation of the keto acid to 3-methylbutanal by *S. lactis* var. *maltigenes*, and the apparent inability of *S. lactis* to attack the keto acid lead to the conclusion that decarboxylation of α-ketoisocaproic acid is an important differentiating physiological characteristic between the two organisms. The pathway of leucine degradation to 3-methylbutanal by *S. lactis* var. *maltigenes* may be schematically represented as follows:

$$\text{Leucine} + \alpha\text{-ketoglutaric acid} \xrightleftharpoons{\text{pyridoxal phosphate}} \alpha\text{-ketoisocaproic} + \text{glutamic acid}$$

$$\alpha\text{-ketoisocaproic} \xrightarrow{Mg^{++},\ \text{thiaminpyrophosphate}} \text{3-methylbutanal} + CO_2$$

SUMMARY

Acetone powders of both *S. lactis* and *S. lactis* var. *maltigenes* were shown to possess a transaminase system which effects a transfer of the amino group of leucine to α-ketoglutaric acid, resulting in the formation of α-ketoisocaproic acid and glutamic acid. This enzyme system is believed to require pyridoxal phosphate as a cofactor and was found to be active at pH 8.4. Although the cell preparations effected the removal of the amino group from leucine at pH 4.6, no concurrent conversion of α-ketoglutaric acid to glutamic acid was observed.

Manometric studies demonstrated the presence of a thiaminpyrophosphate-mediated α-ketoisocaproic acid decarboxylase in dialyzed acetone powders of *S. lactis* var. *maltigenes*, which was absent in similar preparations of *S. lactis*. The detection of 3-methylbutanal in the reaction mixtures from the manometric experiments confirmed the decarboxylative mechanism.

ACKNOWLEDGMENTS

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AMINES IN CHEDDAR CHEESE

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Amines and related compounds probably play an important part in flavor development in Cheddar cheese. These in turn are related to the bacterial enzyme systems present. In this study the presence of a number of amines in ripening cheese was determined and their relation to cheese flavor was studied by chromatographic methods. *Editor.*

Among the more interesting compounds in Cheddar cheese, the amines as a group have received relatively little attention with respect to cheese ripening. Recent studies *(1, 9, 10)* have dealt either with a few cheeses or with a few of the compounds.

In a reappraisal of colored areas on two-dimensional amino acid chromatograms of some Cheddar cheese, Silverman *(13)* expressed the belief that one of the large areas, hitherto unidentifiable, consisted of two or three amines of the type usually associated with unpleasant flavors or odors.

As several lots of experimental Cheddar cheese designed initially by the authors for other research purposes had developed strong unclean flavors and in view of the availability of a refined method for amines on a large scale, an excellent opportunity was presented to study more fully the nature of aromatic amines in cheese. Later the investigation was extended to commercial Cheddar cheese.

METHODS

Cheese samples. A series of raw and pasteurized milk Cheddar cheeses from the same milk supply was made according to the directions of Lochry *et al. (11)* and ripened under vacuum in tin cans at 60° F. for 6 months. Observations were made periodically for flavor, soluble protein, amines, and related compounds.

Twenty-three samples of mature commercial Cheddar cheese, 11 from raw milk and 12 from pasteurized milk, were analyzed in the same manner.

Amine extraction and resolution analysis. Ten g. of cheese was ground to a paste in a mortar with 10 ml. of 20°-25° C. water. The slurry was filtered through Whatman No. 12 paper into a test tube and washed with another 10 ml. of water. The cheese filtrate was placed in a boiling water bath for 10 minutes and then cooled to room temperature. To a 15-ml. aliquot of this filtrate 1.5 ml. of 50% trichloroacetic acid was added. This mixture was well agitated and after 5-8 minutes was filtered through Whatman No. 42 paper.

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Five ml. of this clear acid filtrate was extracted and tested for total amines by using the new tyramine procedure of Silverman and Kosikowski *(14)*. A few minor modifications are advocated because of the more effective extraction of certain amines other than tyramine. For example, 15 ml. of phosphate-sulfate buffer, pH 12, plus 1.5 ml. of 10% sodium hydroxide was used instead of the 16-ml. portion of the phosphate-sulfate buffer. In the receiving flask 2 ml. of dilute hydrochloric acid, 1 part concentrated HCl to 200 parts H_2O, replaced the dilute sulfuric acid.

The contents of the receiving flask, after extraction, were removed to a truncated test tube, frozen, and dried under vacuum. The residue was dissolved in 0.3 ml. of water and a 0.02 ml. aliquot was spotted on Whatman No. 4 sheet filter paper. After the spots were dried, the paper was chromatographed in a single dimension with a butanol-acetic acid-water solvent mixture (ratio 4:1:5), which had been equilibrated for at least 3 days *(2)*. Eighteen hours at 72° F. is usually sufficient for the solvent run. The papers were dried at room temperature and sprayed with a ninhydrin-butyl alcohol mixture and left at room temperature for 24 hours until maximum color development was attained.

For more complete identification an aliquot, 0.03-0.04 ml., was spotted on a 22″ × 18″ Whatman No. 4 sheet filter paper and chromatographed in two dimensions by using a phenol and collidine-lutidine solvent system.

RESULTS

Amines in experimental cheese. In the series under examination two lots of Cheddar cheese were made from raw milk and five lots were from milk pasteurized at 161.5° F. for 15.5 seconds. Although all the cheese was from the same milk supply and manufactured under identical conditions with but a slight variance in amounts of starter, only the raw cheese had developed unclean flavor. This defect was very evident after 2 months of ripening at 60° F. and persisted until the end of ripening at 6 months.

By using single-dimension chromatographic techniques on residues obtained by amine extraction, at least seven ninhydrin reacting areas of varying intensity were observed with these raw cheeses and at least six with the pasteurized cheeses. Presumably, each of these areas represented amines, but positive identification was not possible in all instances. Photographic reproductions of these papers (Figure 1) show only a few of the observed areas to advantage. However, the large colored area at the top of the paper is of major interest. This area, of low *rf* value, was found only with raw milk cheese and was absent in the experimental pasteurized milk cheese. Comparisons with standard solutions indicated that three amines, cadaverine, putrescine, and agmatine, potentially could occupy this area. Resolution of duplicate cheese extracts with a two-dimensional chromatographic pattern (Figure 2) and comparison against pure compounds established the presence of cadaverine and putrescine in these raw milk cheeses and the absence of detectable amounts of agmatine, as indicated by a negative Sakaguchi reaction *(2)*. The interesting two-phase characteristic of the area displayed by cadaverine (Figure 2) was observed also with pure solutions of this amine.

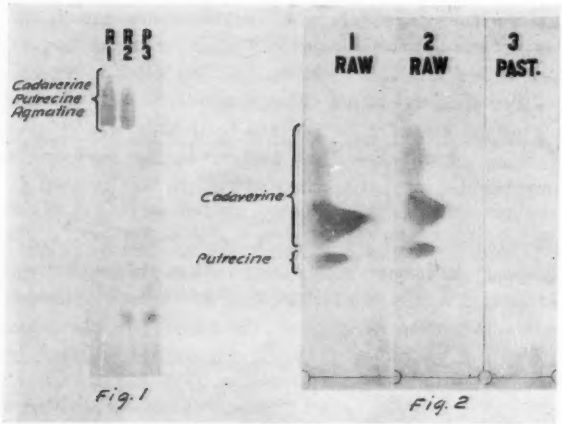

FIG. 1. Single-dimension chromatogram of amines in experimental Cheddar cheese, Series A. R = raw; P = past.

FIG. 2. Resolution of cadaverine-putrescine-agmatine area of experimental Cheddar cheese by two-dimension chromatography. Series A.

Amines in commercial cheese. In 23 commercial Cheddar cheeses, photographic reproductions of single-dimension chromatograms (Figure 3) show a number of ninhydrin reacting compounds, soluble in ether under alkaline conditions. The areas representing these compounds are similar to those observed for experimental cheese except that small but nevertheless detectable cadaverine-putrescine areas were observed with some of the pasteurized milk cheese. Apparently cadaverine (Ca) and putrescine (Pu) are present in most of these cheeses in varying quantity, whereas agmatine (Ag) based on a negative Sakaguchi reaction is not present in detectable quantities. Another amine, histamine (Hi), appears to be present in relatively low concentrations.

The conditions for the amine extraction procedure were purposely established by the addition of sodium hydroxide to favor recovery of cadaverine, putrescine, agmatine, histamine, and tryptamine but not tyramine. Even under the more alkaline conditions, recovery of agmatine is not as complete as for other of the amines, and as a result the lower sensitivity may be a factor in its absence.

The next major line of areas (Figure 3) has been identified as the aromatic amine, tyramine (Ta). Relative concentrations noted here are of a similar pattern to the values obtained on the same cheese by the quantitative method of Silverman and Kosikowski *(14)*. Closely associated and slightly below the tyramine area is the tryptamine area (Tp). Through observations on many samples of cheese it was concluded that very few tryptamine areas occurred in the average Cheddar cheese and that these exist only as traces.

The last line of colored areas (Figure 3) is interesting because of the relatively large concentration of color shown and because these areas are common to

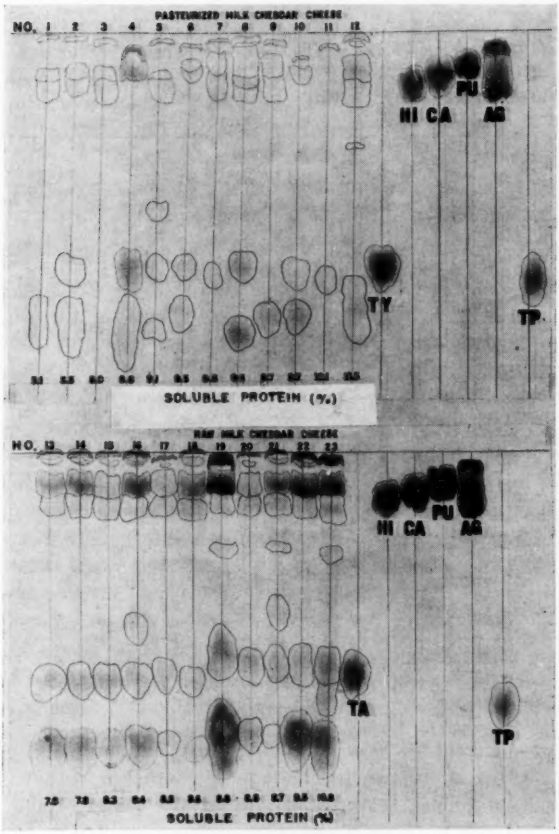
PASTEURIZED MILK CHEDDAR CHEESE
NO. 1 2 3 4 5 6 7 8 9 10 11 12
HI CA PU AG
TY
TP
SOLUBLE PROTEIN (%)
RAW MILK CHEDDAR CHEESE
NO. 13 14 15 16 17 18 19 20 21 22 23
HI CA PU AG
TA
TP
SOLUBLE PROTEIN (%)

FIG. 3. Aromatic amines in 23 commercial Cheddar cheeses by single-dimension paper chromatographic separation. Pure compounds—Hi = histamine; Ca = cadaverine; Pu = putrescine; Ag = agmatine; Ty = tyramine; Tp = tryptamine.

most of the cheese. No identification of this line of areas, presumably aromatic or aliphatic amines, has been made at the present time.

In general, raw milk Cheddar cheese displayed the greater concentration of amines as represented by the greater intensity of color of areas. With either raw or pasteurized milk cheese, the concentration of soluble protein was not necessarily related to amine concentration, a point well illustrated when pasteurized milk cheese No. 4 and raw milk cheese No. 19 in Figure 3 are considered. Block *(1)*, earlier, analyzed two Cheddar cheeses, raw and pasteurized, and observed in both traces of histamine. Cadaverine was found only in the raw milk cheese, and putrescine was undetected in these two cheeses. A greater sampling of Cheddar cheese might have shown the presence of all three compounds, as indicated from the present data.

TABLE 1

The relationship between flavor, γ-amino-butyric acid, and the aromatic amines of the cadaverine-putrescine group in commercial Cheddar cheese

Cheese No.	Flavor quality	Intensity of cheese flavor[a]	γ-amino-butyric acid	Cadaverine-putrescine area
		Raw cheese		
18	41—Excellent	+−	0.0[b]	2.0[b]
21	38—Uc	++−	1.0	2.0
20	38—Uc, A	++−	3.0	1.0
16	38—Uc	++	3.0	3.0
15	37.5—Uc	++	9.0	2.0
17	37.0—Uc	++−	0.5	1.0
22	37.0—Uc, Fr	+++	6.0	3.0
13	36.5—Rancid	+	14.0	2.0
14	36.0—Uc	++	12.0	3.0
23	36.0—Uc	+++	8.0	3.0
19	35.5—Uc	±	9.0	3.0
		Pasteurized cheese		
1	40—Excellent	+	0.0	0.2
2	40—Excellent	+	0.0	0.2
6	40—Excellent	++−	0.0	0.5
9	39—A	+−	0.0	0.3
3	39—Flat	−	0.0	0.2
12	38.5—B	+−	0.0	1.8
7	38.5—A	+−	0.0	0.3
10	38.5—Heated	+−	0.0	0.3
11	38.0—B, A	++−	3.0	0.0
4	37.5—Fr	+++	2.0	3.6
5	37.0—B, A	+++	1.0	0.2
8	36.0—Uc	−−−	0.0	0.5

[a] Reference is to typical Cheddar flavor.

[b] Values represent relative indices obtained by multiplying area of spot by color intensity value. Uc = unclean, A = acid, Fr = fermented, B = bitter.

γ-Amino-butyric acid in cheese. Though not an amine, this compound is formed, in a manner similar to the amines, by decarboxylation. From routine two-dimensional amino acid chromatograms of the cheese under study it was possible to evaluate the γ-amino-butyric area, aided further by the confirmatory selective technique of Crumpler and Dent *(4)*. A large concentration of this compound was observed with the two experimental raw cheese lots, but relatively small amounts were observed with pasteurized experimental cheese. It is also apparent (Table 1) that this compound is invariably associated with commercial raw milk cheese although varying widely. It was not very evident in commercial pasteurized milk Cheddar cheese, but in certain circumstances small amounts were observed (Table 1).

Flavor of cheese versus amines and γ-amino-butyric acid. The small number of samples involved with their limited flavor range does not permit anything more than brief speculation as to the direct influence of these decarboxylation compounds on cheese flavor. There is little to suggest from these data that any of these compounds exert, alone, any greater influence on typical cheese flavor than do the individual amino acids or peptides.

Logically, such amines as cadaverine or putrescine are associated with unpleasant flavors or odor, if only because of their names. Actually, in pure state

their taste sensation is somewhat like that of burnt rubber. In this study although the raw cheese had significantly higher levels of these amines than did pasteurized cheese, little or no relationship could be shown between their concentration and unclean flavor (Table 1). Some degree of direct relationship does appear to exist between γ-amino-butyric acid and unclean flavor in raw milk cheese (Table 1). Though γ-amino-butyric acid is not by itself a particularly offensive compound, it is considered to result mainly from the activity of bacterial enzymes of the *Escherichia coli* species. Indirectly, its presence may indicate intensive abnormal fermentation reactions resulting in unclean flavor.

DISCUSSION

Amines and related compounds, such as γ-amino-butyric acid, apparently are normal complements of most Cheddar cheese and particularly of raw milk cheese. Undoubtedly, these play a part in determining the flavor make-up of the cheese, but with the exception of γ-amino-butyric acid the exact nature of this role was not clearly evident in the present study. More than any other factor, the type of bacteria present in the cheese and their bacterial enzyme systems appear to reflect the nature and concentration of amines likely to be found. Though possessing bacterial enzymes common to most bacteria, nevertheless, a number of organisms of cheese can be characterized by the presence of certain specific bacterial enzyme systems.

It is reasonable to assume from the present results that ripening Cheddar cheese contains active bacterial decarboxylase systems specific not only for tyrosine but also for a number of additional amino acids. The following reactions are indicated in ripening Cheddar cheeses, operating at various stages of cheese development and at different rates of speed.

a) Glutamic acid $\longrightarrow$ γ-amino butyric acid + CO_2
b) Tyrosine $\longrightarrow$ tyramine + CO_2
c) Lysine $\longrightarrow$ cadaverine + CO_2
d) Arginine $\longrightarrow$ urea + ornithine $\longrightarrow$ putrescine + CO_2
e) Histidine $\longrightarrow$ histamine + CO_2
f) Tryptophane $\longrightarrow$ tryptamine + CO_2

The numbers of organisms capable of surviving in cheese and possessing one or more of the above amino acid decarboxylating systems are relatively few. Gale *(5)* found only the first five amino acids capable of being decarboxylated by these relatively few microorganisms. Recently, several more have been added to this list *(3, 7)*.

Among the bacteria commonly associated with cheese, the lactic acid streptococci represented by *Streptococcus lactis* possess weak decarboxylating systems capable only of carrying on reaction *d*. The enterococci represented by *S. faecalis (6, 7)*, though capable of completing reaction *d*, are known for their active tyrosine decarboxylating system *b*, present in most strains. Except for the lactobacilli *(12, 15, 33)*, which may be involved in arginine decarboxylation, most

of the other groups of organisms capable of producing multiple decarboxylating enzymes are the clostridia, bacilli, and the escherichia. The last group *(5)* in general possesses the widest range and strongest activity of bacterial decarboxylases and is probably more responsible for products such as γ-amino-butyric acid, cadaverine, and putrescine than are any other bacteria associated with cheese.

It is a little difficult to explain the presence of even traces of tryptamine resulting from bacterial decarboxylation since Gale *(5)* could not successfully demonstrate decarboxylation of this type through bacteria. Though it does not appear likely that a natural milk amino acid decarboxylase system exists, a need is suggested for further studies on the natural and bacterial sources of amino acid decarboxylases and deamidases in dairy products.

SUMMARY

A number of experimental and commercial Cheddar cheeses were examined for free amines. Among the amines definitely observed were cadaverine, putrescine, tyramine, histamine, tryptamine, and a compound presumed to be an amine and present in relatively large concentration. The decarboxylation product of glutamic acid, γ-amino-butyric acid, was also conspicuous in many of the cheeses. Raw milk cheese normally contained higher levels of the amines and γ-amino-butyric acid than did pasteurized milk cheese after comparable ripening periods. Soluble protein was not closely related to amine concentration.

Strong unclean flavors predominating in experimental raw milk cheese were accompanied by large chromatographic areas identified as cadaverine and putrescine and by large areas representing γ-amino-butyric acid. In commercial cheese no relationship within the raw cheese group could be found between the concentration of amines and unclean flavor, but levels of γ-amino-butyric acid generally increased with increases in the intensity of unclean flavor.

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THE RELATIVE FEEDING VALUE OF ALFALFA HAY AND ALFALFA LIGHT TIMOTHY MIXED HAY AT APPROXIMATELY THE U. S. NO. 1 GRADE LEVEL

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The relationships between hay grades and classifications, as defined by accepted standards, and true feeding value have not been definitely established. This study reports results of an investigation of the relative feeding value of hays classified as Alfalfa Light Timothy Mixed (10-15% timothy) by using 24 Holstein heifers as the experimental animals. The resulting weight gains do not justify the present 5% limit on timothy in alfalfa hay by U. S. standards. *Editor.*

The present system of grading hay according to standards published by the U. S. Department of Agriculture *(5)* has contributed much in the way of uniform definitive terminology. As a result the system and its terminology are rather widely used in the hay trade, for reporting of experiments, and in educational publications. However, the relationships between hay grades and classifications, as defined by the standards, and true feeding value have not been adequately investigated.

Alfalfa, being the major legume hay for dairy farms, has received more attention in this respect than most other classes of hay. A comparison of U. S. No. 1 Extra Leafy Green Alfalfa Hay and U. S. No. 3 Leafy Brown Alfalfa Hay[1] by Kelkas and Gullickson *(4)* showed the former to be of higher feeding value as measured by weight gains in dairy heifers and the need for grain supplements. In work previously reported by the authors *(2)* it was shown that in alfalfa hay of U. S. grades No. 1, No. 2, and No. 3, the higher grades were associated with significantly higher feeding value, although some overlapping of grades occurred. More recent work reported by the authors *(3)* demonstrated that hay classified as Alfalfa Heavy Timothy Mixed having an average timothy content of 44% was of significantly lower feeding value than hay classified as alfalfa, in which class the timothy content is limited to 5%.

Alfalfa normally matures at an earlier date than timothy, the harvesting date of alfalfa-timothy mixtures usually being governed by the maturity stage

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[1] These grade designations are not in accord with the USDA standards *(5)*.

of the predominant specie. Thus, one would expect to find relatively more mature timothy in mixtures having a large percentage of timothy but relatively less mature timothy in mixtures containing a small percentage of timothy.

The experiment reported here was undertaken to determine whether or not there were significant differences in feeding value between hays classified as Alfalfa and hays classified as Alfalfa Light Timothy Mixed, having a 10-15% timothy content.

EXPERIMENTAL PROCEDURE

An attempt was made to obtain three lots of U. S. No. 1 Alfalfa Hay and three lots of U. S. No. 1 Alfalfa Light Timothy Mixed Hay. Hay lots were selected on the basis of the grade assigned by an official hay grader (before purchase). However, the final grade of each lot was determined by averaging the grade given to samples taken at 10-day intervals during the feeding trial. Each of these samples was a composite of borings taken from several bales during each 10-day period.

Twenty-four Holstein heifers, 9-15 months of age at the beginning of the experiment, were divided into six balanced groups, and each group was fed one lot of hay as a sole ration for a period of 150 days, beginning November 13, 1953. Average ages and body weights of the animals used are presented in Table 1. Heifer group A was fed hay lot A, group B was fed lot B, etc.

TABLE 1

Average age and body weights of heifers at start of feeding experiment

Number of animals	Age	Body weight	Number of animals	Age	Body weight
	(mo.)	*(lb.)*		*(mo.)*	*(lb.)*
Group A fed Lot A hay			Group D fed Lot D hay		
4	12.7	718	4	13.0	719
Group B fed Lot B hay			Group E fed Lot E hay		
4	12.8	721	4	12.8	720
Group C fed Lot C hay			Group F fed Lot F hay		
4	12.9	725	4	12.6	723
Av. of groups A, B, and C			Av. of groups D, E, and F		
12	12.8	721	12	12.8	721

All animals were on a hay and grain ration for about 1 month before the start of the experiment. Previous to that time the older animals had been on pasture and the younger animals on dry feed in the calf barn. The experimental ration consisted of hay only and was fed twice daily ad libitum. The amount of hay fed and refused by the individual animals was recorded daily. The amount fed was frequently adjusted so that the refusal would be about 10%.

The hays were carefully sampled for grade and chemical analysis. The sampling procedure was as follows: Every 10 days during the experiment several bales from each lot were sampled, by boring. The bales from one sampling were fed during the period preceding the next scheduled sampling. The dry-matter content of the sample was determined and a portion was reserved for grade determination, the remainder being then composited for three 10-day periods and analyzed for protein, crude fiber, ether extract, and ash according to the official methods of the Association of Official Agricultural Chemists *(1)*. The refusal from each heifer group was sampled once each 10 days and analyzed for dry matter.

The animals were housed in a stanchion barn and turned into an exercise lot twice daily. Water and a mineral mixture of equal parts bone meal and salt containing trace elements were available in the exercise lot. Wood shavings or sawdust was used as bedding. Live weights were obtained initially and on the last three days of each 10-day period.

RESULTS

The grades finally assigned to the hay lots on the basis of the 10-day samples are presented in Table 2. Lots A, B, and C, selected for U. S. No. 1 Alfalfa Hay, met the requirements for this grade with the exception of Lot A, which had 8.8% foreign material (5.0% maximum allowed) and 39.1% leafiness of alfalfa (40.0% minimum allowed). Lot A was therefore graded U. S. No. 2 Green Alfalfa Hay. The average grade of the three lots (A, B, and C) was U. S. No. 1 Alfalfa Hay.

Lots D, E, and F contained 12.4, 9.6, and 11.2% timothy, respectively, and were therefore classified Alfalfa Light Timothy Mixed Hay, 5 to 30% timothy being the allowed range of timothy content for this classification. Lots D, E, and F with 38.9, 38.2, and 34.1% of leaves in the alfalfa, respectively, failed to meet the leafiness requirement for grade U. S. No. 1. Lots E and F with 56 and 52% green color, respectively, also failed to meet the 60% minimum color requirement for grade No. 1. These deficiencies were sufficient to reduce all three lots to a U. S. No. 2 grade. Lot F, however, was further reduced to U. S. No. 3 grade because it contained 12.5% of foreign material, 10% being allowed in grade U. S. No. 2. The average grade of lots D, E, and F was U. S. No. 2 Alfalfa Light Timothy Mixed Hay.

The average body weight gains and feed consumption rates of the animal groups are presented in Table 3. The average daily gain per day per heifer for groups A, B, and C (fed Alfalfa Hay) ranged from 1.61 to 1.73 lb. with an average for the three groups of 1.67 lb. The average daily gains for groups D, E, and F ranged from 1.40 to 1.73 lb. per heifer with an average for the three groups of 1.55 lb. Statistical analysis (analysis of variance) of the average daily live weight gains showed the gains of group F to be significantly lower than those of groups A, C, and D. All other differences between groups were not significant. The difference in average weight gains between animals fed

TABLE 2

Characteristics and grades of hays used

Lot	Alfalfa	Timothy	Grass	Clover	Foreign material	Leafiness of alfalfa	Color		U. S. Grade designation
	(%)						(Hue)	(% green)	
A	97.6	0	2.2	0.2	8.8	39.1	7.47y	67	U. S. No. 2 Green Alfalfa Hay
B	99.8	0	0.1	0.1	3.4	41.3	7.37y	66	U. S. No. 1 Alfalfa Hay
C	96.2	0	3.7	0.1	2.6	42.3	7.12y	65	U. S. No. 1 Alfalfa Hay
Av. A-B-C	97.9	0	2.0	0.1	4.9	40.9	7.32y	66	U. S. No. 1 Alfalfa Hay
D	87.6	12.4	0	Trace	5.0	38.9	6.36y	60	U. S. No. 2 Green Alfalfa Light Timothy Mixed Hay
E	90.2	9.6	0	0.2	4.5	38.2	5.77y	56	U. S. No. 2 Alfalfa Light Timothy Mixed Hay
F	87.0	11.2	0	1.8	12.5	34.1	5.26y	52	U. S. No. 3 Alfalfa Light Timothy Mixed Hay
Av. D-E-F	88.2	11.1	0	0.7	7.3	37.1	5.80y	56	U. S. No. 2 Alfalfa Light Timothy Mixed Hay

TABLE 3

Gain in body weight and hay consumption per heifer

Total gain	Av. daily gain	Hay per day			Dry matter per day			Dry matter consumed per lb. gained
		Fed	Refused	Consumed	Fed	Refused	Consumed	
				(lb.)				
				Group A fed hay Lot A				
248	1.65	22.9	2.4	20.5	20.1	2.1	18.0	10.91
				Group B fed hay Lot B				
241	1.61	23.9	2.5	21.4	21.1	2.1	19.0	11.80
				Group C fed hay Lot C				
260	1.73	23.8	2.4	21.4	20.9	2.1	18.8	10.87
				Av. for groups A, B, and C				
250	1.67	23.5	2.4	21.1	20.7	2.1	18.6	11.14
				Group D fed hay Lot D				
260	1.73	23.8	2.4	21.4	20.7	2.1	18.6	10.75
				Group E fed hay Lot E				
227	1.51	22.3	2.4	19.9	19.6	2.1	17.5	11.59
				Group F fed hay Lot F				
210	1.40	22.5	2.3	20.2	19.6	2.0	17.6	12.57
				Av. for groups D, E, and F				
232	1.55	22.9	2.4	20.5	20.0	2.1	17.9	11.55

Alfalfa (groups A, B, and C) and the animals fed Alfalfa Light Timothy Mixed (groups D, E, and F) also was not significant.

Little difference in palatability was observed, all six lots being consumed at a good rate. However, the rates of dry matter consumption on lots E and F were lowest, being 17.5 and 17.6 lb., respectively, per heifer per day. Lot F with 12.5% foreign material also produced the lowest rate of gain.

The average dry matter content and the chemical composition of the dry matter of the hays are presented in Table 4. On the basis of averages, the hays

TABLE 4

Average dry matter content and chemical composition of the dry matter of the hays fed

	Dry matter	Dry matter constituents				
		Protein	Ether extract	Fiber	N-free extract	Ash
				(%)		
Lot A	87.66	16.87	2.08	26.65	46.01	8.39
Lot B	88.24	19.54	1.95	25.82	44.29	8.40
Lot C	87.48	19.71	2.09	27.12	43.94	7.14
Lot D	86.97	18.23	1.76	26.01	45.95	8.05
Lot E	88.10	17.42	1.47	29.66	44.33	7.12
Lot F	87.24	17.50	1.66	30.54	42.41	7.89
Av. A-B-C	87.79	18.71	2.04	26.53	44.74	7.98
Av. D-E-F	87.44	17.72	1.63	28.74	44.22	7.69

classified as Alfalfa (A, B, and C) were of a slightly higher chemical quality than those classified as Alfalfa Light Timothy Mixed (D, E, and F). The alfalfa hays averaged somewhat higher in per cent protein and somewhat lower in per cent crude fiber. Differences in chemical quality between individual lots were not marked; however, lot F showed generally lower values in this respect.

DISCUSSION

The similarity in the weight gains produced by all the hay lots in spite of their dissimilarity in timothy content demonstrated that the inclusion of up to 12.4% timothy in alfalfa hay had no significant effect on feeding value as measured by this experiment. This was true even though the hays containing timothy had an additional slight disadvantage as regards the quality of the alfalfa portion of the hay. For practical purposes, however, lots D and E could be considered as being of a No. 1 grade since they were so close to meeting the color and leaf requirements for this grade. The fact that lot F had a feeding value significantly lower than lots A, C, and D can hardly be attributed to its timothy content since lot D had an even higher timothy content. It is much more likely that its higher content of foreign material and lower content of alfalfa leaf and green color accounted for the lower feeding value.

The average of the results obtained from the three lots in each class would probably be applicable to most of the market hay falling into these two classifications. Certainly on the basis of these average results, it would appear that 10-15% of timothy could be allowed in the class Alfalfa, at the No. 1 grade level, with no appreciable alteration of the feeding value. Since it is possible that animals might be more sensitive to the inclusion of these amounts of timothy in the lower grades of alfalfa, additional data concerning these lower grades should be obtained before making general conclusions or recommendations regarding changes in the definitions of the classes Alfalfa and Alfalfa Light Timothy Mixed. Additional investigations directed toward obtaining such data are now under way at this station.

This experiment also demonstrated that dairy heifers between 9 and 20 months of age will make satisfactory gains if fed all the good quality hay they will eat. This is in agreement with previously reported data *(2, 3)*.

SUMMARY

Three lots of hay with an average grade of U. S. No. 1 Alfalfa Hay and three lots with an actual average grade of U. S. No. 2 Alfalfa Light Timothy Mixed Hay (9.6-12.4% timothy) but close to a No. 1 grade were purchased. When the six lots of hay were fed as the sole ration to six groups of dairy heifers for 150 days all groups of animals made satisfactory gains. Differences in the body weight gains of heifers on the two different types of hay were not statistically significant. Results demonstrated that in the quality of alfalfa used, the inclusion of up to 12.4% timothy hay does not reduce feeding value significantly. The advisability of the present 5% limit on timothy allowed in the class Alfalfa Hay (official U. S. standards) is questioned.

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COMPARATIVE EFFECTS OF CRYSTALLINE ANTIBIOTICS AND CRUDE ANTIBIOTIC SUPPLEMENTS (AUREOMYCIN AND TERRAMYCIN) ON THE GROWTH AND METABOLISM OF YOUNG DAIRY CALVES[1]

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Although the feeding of aureomycin and terramycin to young dairy calves has been shown to be beneficial, the relative feeding value of crystalline antibiotics and antibiotic supplement has not been definitely determined. To investigate this problem experiments were performed that involved standard feeding practices with a milk-starter-hay system. The growth rates of 40 calves were observed from 2 to 86 days of age. Certain beneficial effects of the feeding of antibiotics were observed. *Editor.*

Research work concerning the value of feeding antibiotics to young dairy calves recently reviewed by Lassiter *(5)* indicates that both aureomycin and terramycin improve the growth rate, increase feed efficiency, and reduce the incidence of scours in young dairy calves. The relative feeding value of crystalline antibiotics as compared with the antibiotic supplement, however, has not been definitely determined *(2, 3, 9, 10)*.

Loosli and Wallace *(8)* observed that crystalline aureomycin produced a growth response similar to that secured from an APF supplement that contained aureomycin. Rusoff *et al. (9, 10)* observed similar results with both forms of aureomycin. Bloom and Knodt *(3)*, however, observed in feeding trials involving both crystalline aureomycin and aureomycin supplements at three different levels of antibiotic feeding that in general the calves that were fed the crude antibiotic supplements grew at a slightly faster rate than calves fed the same amount of crystalline aureomycin. Bartley *et al. (2)* fed calves two levels of aureomycin, 45 and 90 mg., daily from both crystalline aureomycin and the aureomycin supplement, Aurofac. Growth data from these trials indicated that calves fed 45 mg. of aureomycin from Aurofac daily from birth to 12 weeks of age grew at a significantly faster rate than calves fed an equivalent amount of crystalline aureomycin, but from 13 to 25 weeks of age the calves fed the crystalline antibiotic grew at a significantly faster rate than all other calves. Reasoning from the results of this study, these workers postulated the presence of a factor(s) in Auro-

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fac, not in crystalline aureomycin, that benefited the calves early in life until rumen synthesis provided this factor.

Lassiter *et al. (7)* reported that aureomycin had no effect on the digestion of feed nutrients by dairy calves under 12 weeks of age. It was observed in these studies, however, that aureomycin significantly lowered blood levels of nonprotein nitrogen in the calves for the first 7 weeks of life. Since nitrogen balance trials were not conducted, it was not possible to determine whether this indicated an increase in nitrogen utilization in calves fed aureomycin.

The present study was conducted to determine the relative effect of crystalline antibiotic and crude antibiotic supplements (aureomycin and terramycin) on the growth, feed consumption, feed utilization, digestibility of feed nutrients, nitrogen retention, and the blood levels of urea nitrogen and nonprotein nitrogen in young dairy calves.

EXPERIMENTAL PROCEDURE

The feeding and management of the calves was essentially the same as reported previously by Lassiter *et al. (7)*. Five comparable groups of six Holstein and two Jersey calves 2 days of age were raised to 86 days of age on a limited milk-starter-hay system. Calves were allowed to remain with their dams for the first 48 hours of life and were then weighed, placed in individual pens, and subjected to an experimental regime of limited milk along with free-choice feeding of alfalfa hay. The milk feeding schedule was the same as reported previously by Lassiter *et al. (6)*. Beginning at 7 days of age, the calves were fed an all-plant basal calf starter composed of 240 lb. ground yellow corn, 150 lb. wheat bran, 150 lb. linseed oil meal, 360 lb. crimped oats, 300 lb. corn distillers' solubles, 15 lb. iodized salt, 15 lb. steamed bone meal, 600 g. of a vitamin A and D supplement, and 65 lb. molasses. Starter consumption was limited to 5 lb. daily for Holstein calves and 4 lb. daily for Jersey calves. This starter contained 19.7% protein and 6.3% fiber.

Group 1 was considered the control group and was fed the basal calf starter. Group 2 received the basal starter plus crystalline aureomycin at the rate of 50 mg. of antibiotic daily for the first 7 weeks; Group 3 received the basal starter plus 50 mg. daily of aureomycin supplied by an antibiotic supplement, Aurofac D, for the first 7 weeks; Group 4 received the basal ration plus 50 mg. daily of crystalline terramycin for the first 7 weeks; and Group 5 received the basal ration plus 50 mg. daily of terramycin supplied by a terramycin supplement (TM-5) for the first 7 weeks. When the calves were 7 weeks of age, all antibiotics were included in the starter at the rate of 15 mg. per pound of starter of either the crystalline antibiotic or the equivalent amount of antibiotic supplement.

Feed consumption records were kept, and observations were made daily as to the incidence of scours and over-all condition of the animals. The calves were weighed weekly, and measurements of height at withers and chest circumference were taken monthly.

Five male calves from each group, four Holsteins and one Jersey, were used in standard digestion and nitrogen balance trials, with total collection of feces

and urine being made from each calf during three separate periods at 5, 8, and 11 weeks of age. Milk was fed at the standard rate during the first collection period. Uniform feed intakes were obtained with most calves during the three collection periods. The actual collection of feces and urine was 5 days in length preceded by a 2-day preliminary period. Chemical analyses of feed and fecal samples were conducted by official A.O.A.C. methods *(1)*.

Blood samples were taken from all calves at 2-week intervals, beginning at 1 week of age and as near the same time of day as possible. Blood urea nitrogen and total nonprotein nitrogen determinations were made immediately. The urea nitrogen determinations were made according to the method of Van Slyke and Cullen *(12)*, and the total nonprotein nitrogen determinations were made by a modification of the method outlined by Folin and Wu *(4)*. Steam distillation was used in place of the chlorometric method outlined by these authors.

RESULTS AND DISCUSSION

The effect of the various antibiotics, crystalline or crude supplements, on the average daily gain, feed consumption, feed efficiency, and the incidence of scours is shown in Table 1. Data indicate that both antibiotics, whether in the crystalline

TABLE 1

Effect of aureomycin and terramycin, crystalline or supplement, on average daily gain, consumption of feed, efficiency of feed utilization and the incidence of scours

Group	Average daily gain[a]	Av. total consumption			Feed per lb. gain[a]	Scours[a]
		Milk[a]	Starter[a]	Hay[a]		
	(lb.)	*(lb.)*	*(lb.)*	*(lb.)*	*(lb.)*	*(days/calf)*
1—Basal	1.09	240.6	176.4	68.3	3.01	2.62
2—Basal plus crystalline aureomycin	1.17	231.1	192.4	64.2	2.91	3.25
3—Basal plus Aurofac	1.24	240.2	205.9	64.8	2.89	1.75
4—Basal plus crystalline terramycin	1.17	249.9	181.7	64.0	2.83	1.88
5—Basal plus TM-5	1.19	253.3	181.8	74.2	2.88	1.38

[a] None of the differences between groups were statistically different.

or crude form, stimulated the growth rate of the calves. None of the differences were statistically significant *(11)*. It appears that crystalline aureomycin, crystalline terramycin, and the terramycin supplement stimulated the growth of the calves approximately an equal amount. These data indicate that the aureomycin supplement, Aurofac, stimulated the growth of the calves slightly more than any of the other supplements, which would support the conclusions of Bartley *et al. (2)*. Since this added stimulation in weight gain was not significantly different statistically from that produced by the antibiotics in other forms, only further work can determine whether Aurofac does contain a factor in addition to aureomycin. The antibiotic supplements caused an increase in skeletal growth similar to the increase in weight. The average increase in height at withers for Groups 1, 2, 3, 4, and 5 was 4.69, 4.94, 5.84, 4.91, and 4.66 in., respectively. The

average increase in chest circumference was 7.06, 8.38, 9.75, 8.56, and 8.53 in. for Groups 1, 2, 3, 4, and 5, respectively. None of the differences between groups in the increase in height at withers were significant. The increase in chest circumference of all antibiotic groups was significantly greater than that of the control calves, and that produced by Aurofac (Group 8) was significantly greater than that produced by the other antibiotics at the 1% level of probability.

The feed data shown in Table 1 indicate that both antibiotics, but particularly aureomycin, stimulated the consumption of starter by the calves but did not appear to have any great effect on the consumption of hay. All antibiotic-fed calves were slightly more efficient in the conversion of feed into weight than were the control calves, with the calves fed crystalline terramycin being slightly more efficient than any other group. The scouring data might indicate that Aurofac, crystalline terramycin, and the terramycin supplement had a greater effect on the incidence of scours than crystalline aureomycin; however, the incidence of scours in this study was relatively low; therefore, probably very little significance can be attached to these values.

TABLE 2

Results of digestion and nitrogen balance trials with calves fed aureomycin or terramycin in either the crystalline or crude form

	Ration				
	1	2	3	4	5
	Control	Cry. Aureo.	Aurofac	Cry. Terr.	TM-5
Av. daily dry matter intake *(g.)*	1623	1489	1688	1395	1570
Nitrogen intake *(g.)*	51.1	46.9	53.5	44.3	49.5
Nitrogen in urine *(g.)*	14.5	14.8	18.5	14.7	16.2
Nitrogen in feces *(g.)*	12.3	11.1	13.3	10.9	12.1
Total excretion *(g.)*	26.8	25.9	31.8	25.6	28.3
Nitrogen retained *(g.)*	24.3	21.0	21.7	18.7	21.2
Per cent retained of intake	47.6	44.8	40.6	42.2	42.8
Apparent digestibility *(%)*					
Dry matter	76.2	75.8	75.9	75.7	75.0
Crude protein	76.9	76.9	76.1	76.0	76.6
Ether extract	85.6	86.6	86.4	84.6	85.8
Crude fiber	50.7	51.3	53.4	49.4	45.7
N-free extract	81.5	80.6	81.1	81.9	81.3

The results of the digestion and nitrogen balance trials are presented in Table 2. Relatively uniform feed consumption was obtained in these studies, considering the ages of the calves involved. The calves fed terramycin had a slightly lower retention of nitrogen than the other groups, which was probably due to the lower intake of nitrogen by this group. The differences among groups were very small and not significant. The calves fed the control ration retained a slightly higher percentage of their nitrogen intake than all other groups.

As shown in Table 2, very little difference existed in the coefficients of apparent digestibility of the various rations. None of these differences were statistically significant. If one disregards the ration being fed, the digestibility of dry matter, crude protein, ether extract, and nitrogen-free extract was highest during the

first collection period (when calves were 5 weeks of age). There was very little difference between the digestion of these nutrients at the 8- or 11-week collection period. The digestion of crude fiber tended to increase with the age of the calf, averaging 47.1% at 5 weeks of age, 47.6 at 8 weeks, and 54.7 at 11 weeks. The retention of nitrogen tended to increase with age of calves, averaging 15.8, 19.1, and 29.0 g. of nitrogen daily for the 5-, 8-, and 11-week digestion trials.

In Table 3 the effect of the various antibiotics on the blood levels of urea and total nonprotein nitrogen is shown. These data indicate that there was very little difference in the average blood urea nitrogen values between the various experimental rations. The calves fed the rations containing either Aurofac or crystal-

TABLE 3

Effect of the antibiotics on blood levels of urea and nonprotein nitrogen of young dairy calves (mg/100 ml.)

Week on expt.	Urea nitrogen					Nonprotein nitrogen				
	Group					Group				
	1	2	3	4	5	1	2	3	4	5
1	12.4	12.3	9.2	10.9	11.6	39.2	38.1	37.1	36.2	35.5
3	11.7	10.5	9.4	9.8	9.6	35.4	35.4	35.6	33.0	33.1
5	9.0	11.0	7.4	8.1	9.0	32.3	33.3	30.9	30.7	31.6
7	10.4	10.7	9.4	8.9	12.4	31.7	31.9	32.4	31.8	32.9
9	12.9	10.7	10.8	10.4	12.3	31.9	32.6	31.1	33.2	30.7
11	10.4	9.4	8.7	10.4	10.6	30.8	31.2	31.4	30.1	30.7
Average	11.1	10.7	9.2	9.8	10.9	33.4	33.7	33.1	32.5	32.5

line terramycin tended to have slightly lower values than any of the other groups, and all antibiotic-fed calves had slightly lower values than the controls; however, none of these differences were statistically significant. The blood total nonprotein nitrogen values of the various antibiotic groups indicate that neither aureomycin nor terramycin in either form had any appreciable effect on the blood levels of this constituent. These data are not in agreement with the results published previously from this station *(7)*, which indicated that Aurofac depressed the blood levels of nonprotein nitrogen of young dairy calves for the first 7 weeks of life. These results, however, are in agreement with those from the nitrogen balance studies, in which an increase was not observed in nitrogen retention when antibiotics were fed. The blood levels of this constituent tended to decrease with age of the calves.

It should be pointed out that a statistically significant increase in growth was not obtained from the feeding of antibiotics in this study. However, since all antibiotic-fed groups grew at a faster rate than the control calves, it is only logical to assume that the antibiotics probably stimulated the growth rate. For this reason and since the antibiotics did not appear to have any appreciable effect upon the retention of nitrogen or the blood levels of total nonprotein nitrogen, it must be assumed that with the criteria used in these studies the feeding of antibiotics to young dairy calves does not appreciably change their nitrogen metabolism.

SUMMARY

Forty new-born dairy calves were used in studying the comparative effects of crystalline antibiotics and crude antibiotic supplements (aureomycin and terramycin) on growth and metabolism. The calves were raised to 86 days of age on a limited milk-starter-hay system.

The control calves gained an average of 1.09 lb. daily; calves fed crystalline aureomycin, 1.17 lb.; Aurofac, 1.24 lb.; crystalline terramycin, 1.17 lb.; and a terramycin supplement (TM-5), 1.19 lb. None of the differences between groups were statistically significant. All calves fed antibiotics increased in chest circumference significantly more than the control calves, and the increase of calves fed Aurofac was significantly greater than that of other antibiotic-fed groups. Only further experimental study will determine whether Aurofac contains a factor(s) in addition to aureomycin. All calves fed antibiotics tended to consume more starter than the control calves, but the antibiotics had very little effect upon the consumption of hay. All antibiotic-fed calves tended to be slightly more efficient than calves not fed antibiotics, as measured by the pounds of feed required per pound of gain. The incidence of scours in this study was very low, but all of the antibiotics except crystalline aureomycin tended to lower the incidence of scours.

Digestion and nitrogen balance studies indicated that neither of the antibiotics in either form had any significant effect upon the digestion of feed nutrients or the retention of nitrogen. Blood studies indicated that neither aureomycin nor terramycin had any effect on the blood levels of urea nitrogen or total nonprotein nitrogen. These results indicate that the feeding of antibiotics to young dairy calves does not alter significantly the nitrogen metabolism of the calf, as indicated by the measurements used in these studies.

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THE EFFECT OF GLYCEROL EQUILIBRATION TIME ON THE FREEZING OF BOVINE SPERMATOZOA IN EGG YOLK–SODIUM CITRATE AND SKIMMILK SEMEN EXTENDERS[1,2]

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There is some difference of opinion among experimenters as to the significance of the length of time that sperm cells remain in a glycerolated extender prior to freezing. The basis of this study was a comparison of results of using 0.5-hour and 18-hour equilibration times on bovine semen in egg yolk–sodium citrate and skimmilk semen extenders. The results were measured in terms of the percentage of motile sperm after thawing as compared with the percentage observed prior to freezing. The study made possible a determination of the differences between individual bulls in relation to recovery percentage and the significance of the length of storage period in evaluating semen samples. *Editor.*

The time of the glycerol equilibration period is a matter of controversy among workers in the field of freezing bovine semen. The equilibration period may be defined as the time that sperm cells remain in a glycerolated extender prior to freezing.

Polge and Rowson *(4)* recommended an equilibration time ranging between 15 and 20 hours when using an egg yolk extender. Miller and VanDemark *(2)*, comparing 2-, 6-, and 18-hour equilibration times when using an egg yolk extender, found the 6-hour period to be superior in terms of percentage of motile sperm cells surviving after freezing. Cragle *et al. (1)*, also using an egg yolk extender, found 14.9 hours to be the most favorable equilibration time between 4 and 28 hours. Saroff and Mixner *(5)* showed a progressive increase in sperm cell survival in an egg yolk extender as the equilibration time was increased from 2 to 18 hours. O'Dell and Almquist *(3)*, using a heated skimmilk extender, did not observe any significant difference in sperm cell survival after freezing when using 0.5-, 4-, and 18-hour equilibration times.

The studies reported here compare the effects of 0.5-hour and 18-hour equilibration times on the freezing of bovine spermatozoa in egg yolk–sodium citrate and skimmilk semen extenders.

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[2] Data in this publication are taken from a thesis submitted by the senior author to the Graduate School of the Clemson Agricultural College, Clemson, S. C. in partial fulfillment of the requirements for the M.S. degree.

EXPERIMENTAL PROCEDURE AND RESULTS

The two extenders used in this work were egg yolk–citrate and skimmilk. The composition of the egg yolk–citrate extender was 20% egg yolk and 80% of a 3% aqueous solution of sodium citrate dihydrate. The skimmilk was separated not later than one day prior to its use, and a Babcock butterfat test was conducted to insure that no skimmilk would be used testing higher than 0.04% butterfat. The skimmilk was heated to 92-95° C. for 3 minutes and then cooled to 5° C. Streptomycin sulfate and potassium penicillin G were added to both extenders at the rate of 500 units each per milliliter.

Split samples of the same ejaculate were extended at a rate of 1 to 25. Glycerol was added to separate containers of extender at double the desired percentage level and then an equal volume of this was added to the extended semen to give a final dilution of 1 to 50. At the same time the glycerol level was reduced to the desired percentage. This glycerolated extender was added to the extended semen in five steps, each at 6-minute intervals. After giving the samples the desired equilibration period, freezing was conducted at a rate of 0.8° C. per minute in a Dewar flask with ethanol and dry ice from 5° to –15° C. and then at approximately 3.5° C. per minute down to –65° C. From this point the reduction in temperature was carried out as rapidly as possible to –75° C. The samples were then placed in a storage cabinet for the final reduction to –79° C.

In thawing, the samples were removed from the storage cabinet and immediately submerged in containers of ice water, where they remained until completely thawed.

The basis of evaluation of this work was the percentage of motile sperm observed after thawing as compared to the percentage observed prior to freezing. This was expressed as per cent recovery and was obtained by use of the following formula:

$$\frac{\text{Per cent of motile sperm after thawing}}{\text{Per cent of motile sperm prior to freezing}} \times 100 = \text{per cent recovery}$$

This work was divided into two phases, which will be discussed separately.

EXPERIMENT 1

Preliminary trials involving a study of the effect of different glycerol levels on the effectiveness of skimmilk as a frozen semen extender. Single ejaculations from 18 bulls were split into each of three skimmilk extenders to contain a final volume of 8, 10, and 12% glycerol. These samples were then frozen as outlined above. Samples of each group were stored for periods of 24 to 48 hours and then thawed. The results of this work are shown in Table 1.

An analysis of variance *(6)* of the combined recovery percentages for both 24 and 48 hours after freezing showed that the differences in recovery percentages were highly significant. From these data it was concluded that an 8% level of glycerol is the superior level insofar as these studies were concerned.

TABLE 1

Recovery of sperm cells diluted with three levels of glycerol in skimmilk and stored at –79° C.

Glycerol level	Recovery after being frozen for 24 hours	Recovery after being frozen for 48 hours
(%)	*(%)*	*(%)*
8	62.7	55.8
10	46.8	45.1
12	50.5	45.0

EXPERIMENT 2

Trials involving 0.5-hour and 18-hour equilibration times with egg yolk and skimmilk extenders. Twelve bulls were selected from Experiment 1 for these studies. They were selected on the basis of past histories of high initial motility of their semen and on the ability of their semen to freeze successfully.

One ejaculation was collected from each bull weekly for a period of 4 weeks. On this basis, all initial motilities ranged between 50 and 70% except for one bull that had three initial ejaculation motilities of 40%. The level of glycerol used in the second experiment was 8% by volume for both the skimmilk and egg yolk–citrate. The citrate level was reduced to 2.76% by the addition of the glycerol.

Each of the 48 ejaculations was split in the following eight ways: egg yolk–citrate (EYC), 0.5-hour equilibration with 48 hours storage; EYC, 0.5-hour equilibration with 10 days storage; EYC, 18 hours equilibration with 48 hours storage; EYC, 18-hour equilibration with 10 days storage; skimmilk (SM), 0.5-hour equilibration with 48 hours storage; SM, 0.5-hour equilibration with 10 days storage; SM, 18 hours equilibration with 48 hours storage, and SM, 18 hours equilibration with 10 days storage. Results are shown in Table 2.

An analysis of variance test was conducted on the recovery percentage figures. Statistically significant differences in per cent recovery of semen were found at the 5% level among bulls and between the equilibration times. Highly statistical significance at the 1% level was found between differences in storage periods.

Highly significant interactions were found between bulls × ejaculations, bulls × extenders, and bulls × equilibration times. The high significance of these interactions confirms the observations of the raw data in which the freezing of a given bull's semen is affected by the type of extender used and the length of

TABLE 2

Recovery of sperm cells of 48 ejaculations from 12 bulls at the end of 48 hours and 10 days storage at –79° C.

Time frozen	Egg yolk–citrate extender		Skimmilk extender	
	Recovery after 0.5-hour equilibration	Recovery after 18 hours equilibration	Recovery after 0.5-hour equilibration	Recovery after 18 hours equilibration
	(%)	*(%)*	*(%)*	*(%)*
48 hours	78.5	76.7	78.8	75.6
10 days	74.4	72.2	73.9	68.6

the equilibration time. The interactions ejaculations × equilibration times and ejaculations × storage were significant at the 5% level.

Retention of motility of samples thawed 48 hours after freezing in Experiment 2 was followed until death of all cells occurred. The average daily readings on all samples are shown in Table 3.

It is obvious from the inspection of these data that none of the thawed semen maintained good motility in storage.

TABLE 3

Recovery retained by sperm cells after thawing from −79° C. to 5° C. and holding at this temperature for 5 days

Day	Egg yolk–citrate extender		Skimmilk extender	
	0.5-hour equilibration	18 hours equilibration	0.5-hour equilibration	18 hours equilibration
	(%)	*(%)*	*(%)*	*(%)*
1	78.5	76.7	78.8	75.6
2	59.6	54.8	61.1	57.1
3	37.0	37.2	42.3	40.2
4	23.9	23.8	27.9	24.7
5	13.8	12.6	16.5	15.7

DISCUSSION

In freezing bovine semen the emphasis should be placed on each individual bull. A determination of the optimal conditions for a particular bull must be made if satisfactory results are to be obtained. In this work semen from 18% of 28 bulls initially studied did not freeze successfully in Experiment 1. From these studies it appears that all work reported in this field should acknowledge whether bulls producing poor freezing semen had to be eliminated before final experimental data are reported.

There was a drop in recovery percentage of frozen semen samples after 10 days storage as compared to samples stored for 48 hours. Since these differences in recovery percentages were highly significant, it is recommended that frozen semen samples be evaluated after a 10-day storage period following freezing. This should give a more accurate appraisal of the stored samples while still providing a test within practical time limits after freezing.

The data clearly show that frozen semen, once thawed, should not be used for artificial insemination beyond the day of thawing. Loss of motility on samples stored after thawing is far more rapid than would be anticipated with samples of unfrozen semen.

SUMMARY

A study was made of the effect of glycerol equilibration time on the freezing of bovine spermatozoa in egg yolk–citrate and skimmilk extenders.

An analysis of variance indicated that the differences in survival motility between 0.5-hour and 18-hour equilibration times were significant at the 5% level and were in favor of the 0.5-hour period. This should not be construed to mean that a 0.5-hour equilibration time is optimal for all semen, since it was found that semen from several bulls responded better to an 18-hour period.

It is indicated that there is considerable variation among bulls in the ability of their semen to freeze successfully.

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THE EFFECT OF VARIOUS DIETARY LIPIDS ON THE BLOOD PLASMA POLYUNSATURATED FATTY ACIDS OF DAIRY CALVES[1]

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Although certain unsaturated fatty acids have been shown to aid in the prevention of fat-deficiency symptoms in experimental animals, the significance of polyunsaturated fatty acids in this respect has not been definitely determined. Studies of the blood plasma of calves fed different types of lipids (milk fat, butter oil, crude soybean oil, hydrogenated soybean oil, and lard) clearly show the effect of dietary lipids on the plasma polyunsaturated fatty acids. Higher plasma arachidonic acid values were maintained in calves fed milk fat. *Editor.*

It is generally recognized that certain of the unsaturated fatty acids are important in the prevention of fat-deficiency symptoms in various animal species. Linoleic acid *(3)* or arachidonic acid *(17)* will prevent characteristic skin lesions and will allow good growth in rats fed fat-deficient diets. Greenberg *et al. (7)* have demonstrated that methyl arachidonate has about 3.5 times the biopotency of linoleic acid when fed to fat-deficient rats. Linolenic acid, on the other hand, has only slight growth-promoting action when fed alone to fat-depleted rats. However, a combination of this acid with suboptimal levels of linoleic acid supports growth equal to that resulting from an amount of linoleic acid equivalent to the combined total of the two acids *(8)*.

Lambert *et al. (11)* and Cunningham and Loosli *(5)* recently reported the development of a fat deficiency in young dairy calves. The deficiency symptoms were prevented and/or corrected by feeding various lipids, but the relationship of polyunsaturated fatty acids to this syndrome was not entirely clear. The present investigation was undertaken to study further the factors affecting the blood plasma levels of the polyunsaturated fatty acids in young dairy calves.

EXPERIMENTAL PROCEDURE

This investigation was conducted in two phases. The first (Experiment I) was initiated to ascertain the early post-natal changes in the levels of linoleic, linolenic, and arachidonic acids in the blood plasma of young dairy calves. The second (Experiment II) was designed to study the effect of various dietary lipids on the blood plasma levels of the polyunsaturated fatty acids in calves fed various milk diets.

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EXPERIMENT I

Procedure. Five calves (three Brown Swiss and two Holsteins) from the Iowa State College dairy herd were allowed colostrum ad libitum from their respective dams for 3 days after birth and were fed whole milk at 6 A.M. on the fourth day. Samples of venous blood (heparin anticoagulant) were drawn soon after birth and at about 10 A.M. on each of the four subsequent days. After centrifugation, the plasma lipids were extracted with alcohol ether (3:1) in a solvent to plasma ratio of 20 to 1. The extract was concentrated and subsequently was saponified with potassium hydroxide at 60° C. for 45 minutes. After cooling, the nonsaponifiable components were removed by three successive extractions with Skellysolve A. The remaining solution was acidified with 25% sulfuric acid (neutral red indicator), and the total fatty acids were extracted three times with Skellysolve A. Aliquots of the combined extract were taken for estimation of the total fatty acids by the microoxidative method of Boyd *(1)*. The plasma polyunsaturated fatty acids were estimated by alkali conjugation by heating the acids with a potassium hydroxide-ethylene glycol reagent for 30 minutes at 180° C. under nitrogen. The isomerization reagent was prepared and the conjugation reactions were conducted according to a modification of the procedure described by O'Connor *et al. (13)*. A Beckman spectrophotometer, model DU, was employed to measure optical densities at wave lengths recommended for estimating dienoic, trienoic, and tetraenoic acids *(2)* and also at 345 and 375 mμ for detecting the presence of pentaenoic and hexaenoic acids *(14, 18)*. The plasma levels of linoleic, linolenic, and arachidonic acids were calculated from the equations developed by Brice and Swain *(2)*.

Results. The mean daily levels of the total fatty acids and of the polyunsaturated fatty acids are shown in Table 1. The level of all polyunsaturated fatty acids was lower at birth than on subsequent days. The increases, during the 4-day period, of the linoleic, linolenic, and arachidonic acid values were approximately tenfold, sixfold, and twofold, respectively, whereas the level of the total fatty acids increased about fourfold. Calculation of the percentage of each of the polyunsaturated fatty acids in the total fatty acids reveals that linoleic acid increased from 10.6 to 28.6% and linolenic acid increased from 1.7 to 3.2%, whereas arachidonic acid decreased from 11.7 to 7.7% during this period. In several individual samples there was no detectable linolenic acid present, which is in agreement with the observations of O'Connell *et al. (12)* on several species.

TABLE 1
Total and polyunsaturated fatty acids in calf blood plasma (Experiment I)

Age of calves	Plasma fatty acids[a]			
	Total fatty acids	Linoleic	Linolenic	Arachidonic
(days)	*(mg/100 ml.)*			
0	27.8 ± 3.6	2.8 ± 0.4	0.6 ± 0.6	3.2 ± 0.5
1	58.1 ± 11.2	12.3 ± 2.6	1.5 ± 0.6	5.9 ± 1.0
2	86.0 ± 7.1	20.2 ± 2.4	1.8 ± 0.8	7.2 ± 0.6
3	103.8 ± 12.6	26.9 ± 2.7	3.6 ± 1.0	7.1 ± 0.9
4	98.4 ± 6.2	28.2 ± 2.7	2.7 ± 0.9	7.3 ± 1.0

[a] Mean values (± standard errors) for 5 calves.

Measurements made at 345 and 375 mμ showed the presence of traces of pentaenoic and hexaenoic acids in most of the samples. Background absorption values (before isomerization) for plasma fatty acids dissolved in isooctane indicated that there were essentially no conjugated acids.

EXPERIMENT II

Procedure. Fifteen calves, ten Holsteins and five Brown Swiss, were divided into five comparable groups. For 3 days after birth the calves remained with their respective dams. Subsequently, the animals were placed in individual stalls bedded with wood shavings and from 4 to 18 days of age they were fed whole milk (approximately 3% fat). During the ensuing 28-day period Group I continued to receive whole milk whereas Groups II, III, IV, and V were fed reconstituted milks containing butter oil, crude soybean oil (expeller), hydrogenated soybean oil, and lard, respectively. The reconstituted milks contained 10% nonfat dry milk solids and 3% oil or fat and were homogenized at a pressure of approximately 3,000 lb. All milks were fed twice daily, via nipple feeders, at the rate of 10 lb. daily per 100 lb. body weight. Each calf received daily 15,000 I.U. of vitamin A and 3,000 I.U. of vitamin D in gelatin capsules. No other feeds were offered. Whenever scouring occurred, the amount of milk fed was reduced by 50%. After the diarrhea subsided, the intake was increased gradually to the normal level.

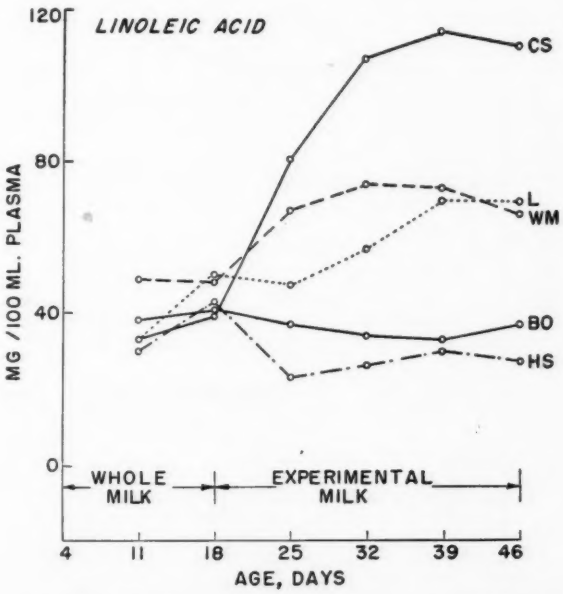

FIG. 1. Effect of dietary lipids on blood plasma linoleic acid. (WM = whole milk, BO = butter oil, CS = crude soybean oil, HS = hydrogenated soybean oil, L = lard.)

When the calves were approximately 11 days of age and at weekly intervals thereafter, samples of venous blood (heparin anticoagulant) were drawn about 3 hours after the morning feeding. After centrifugation the plasma was analyzed for total fatty acids, linoleic acid, linolenic acid, and arachidonic acid as described in Experiment I. The polyunsaturated fatty acid content of the various dietary lipids employed in this investigation also was estimated by the alkali conjugation technique *(13)*.

Results. The effect of the various dietary lipids on the blood plasma linoleic acid levels is shown in Figure 1. During the preliminary whole milk feeding period the values for linoleic acid tended to increase slightly. Subsequently, the group fed crude soybean oil showed a marked increase in plasma linoleic acid. Lesser increases were observed in the whole milk and lard groups, whereas slight decreases occurred in the butter oil and hydrogenated soybean oil groups. Changes in blood plasma linolenic acid values were not so conclusive (Figure 2). However, the group fed hydrogenated soybean oil had the lowest levels during the period when experimental milks were fed, whereas the group fed butter oil had the highest levels. Calves which received milk fat (whole milk and butter oil)

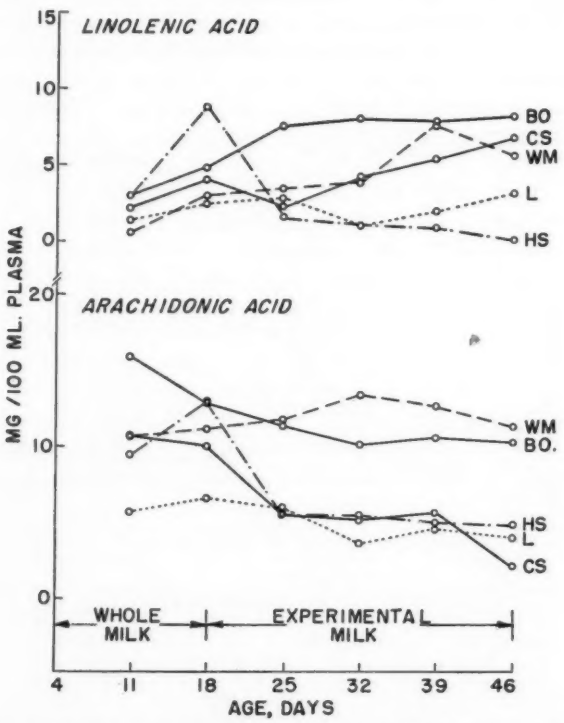

FIG. 2. Effect of dietary lipids on blood plasma linolenic acid and arachidonic acid. (WM = whole milk, BO = butter oil, CS = crude soybean oil, HS = hydrogenated soybean oil, L = lard.)

TABLE 2
Polyunsaturated fatty acid content of dietary lipids fed (Experiment II)

Dietary lipid	Fatty acid		
	Linoleic	Linolenic	Arachidonic
	(%)		
Milk fat (whole milk)	1.25	0.32	0.22
Milk fat (butter oil)	2.16	0.57	0.22
Crude soybean oil	45.47	8.58	0.00
Hydrogenated soybean oil	0.30	0.07	0.00
Lard	9.82	0.64	0.35

consistently maintained higher levels of plasma arachidonic acid than the groups which received lard, crude soybean oil, and hydrogenated soybean oil (Figure 2).

The relationship between the polyunsaturated fatty acids in the dietary lipids (Table 2) and the plasma levels of these acids was somewhat variable. The crude soybean oil contained considerably more linoleic acid than the other lipids; this was reflected in high plasma linoleic acid values in the group fed this product. However, groups fed lard and whole milk had similar plasma linoleic acid values even though the lard contained nearly eight times as much linoleic acid as the milk fat. The low polyunsaturated fatty acid content of hydrogenated soybean oil was reflected in low plasma levels.

The comparative effects of the dietary lipids on the plasma polyunsaturated fatty acids at the termination of the preliminary period and the average of values after 3 and 4 weeks on the experimental milks are presented in Table 3. These

TABLE 3
Summary of the comparative effects of dietary lipids on plasma polyunsaturated fatty acids

Dietary group	Period[a]	Fatty acid		
		Linoleic	Linolenic	Arachidonic
		(mg/100 ml. plasma)[b]		
I				
Milk fat (whole milk)	Preliminary	48.0 ± 4.5	3.0 ± 0.4	11.1 ± 1.3
	Experimental	69.4 ± 6.4	6.8 ± 0.5	11.9 ± 0.3
II				
Milk fat (butter oil)	Preliminary	40.8 ± 4.8	4.9 ± 0.8	12.7 ± 0.7
	Experimental	35.5 ± 5.1	8.2 ± 1.0	10.4 ± 0.8
III				
Crude soybean oil	Preliminary	39.1 ± 1.8	4.1 ± 1.7	9.9 ± 0.5
	Experimental	112.8 ± 17.8	6.4 ± 2.0	3.8 ± 1.0
IV				
Hydrogenated soybean oil	Preliminary	42.9 ± 4.7	8.8 ± 3.9	12.8 ± 1.2
	Experimental	28.9 ± 2.4	0.7 ± 0.4	4.8 ± 0.3
V				
Lard	Preliminary	50.4 ± 13.2	2.5 ± 0.6	6.5 ± 2.1
	Experimental	69.5 ± 4.1	2.8 ± 1.0	4.2 ± 1.3

[a] Preliminary values—1 sample from each calf, taken at the end of the preliminary whole milk feeding period. Experimental values—2 samples from each calf, taken at 3 and 4 wk. after change to the experimental diet.

[b] Each value is an av. for 3 calves (2 Holsteins and 1 Brown Swiss) ± standard error.

TABLE 4

Effect of dietary lipid on the mean percentages of the polyunsaturated acids in the plasma total fatty acids

Dietary group	Period[a]	Linoleic acid	Linolenic acid	Arachidonic acid
		(%)		
I				
Milk fat (whole milk)	Preliminary	42.4	2.6	9.8
	Experimental	44.1	4.4	7.8
II				
Milk fat (butter oil)	Preliminary	29.1	3.4	9.1
	Experimental	31.3	7.3	9.4
III				
Crude soybean oil	Preliminary	33.4	3.2	8.4
	Experimental	75.7	4.1	2.9
IV				
Hydrogenated soybean oil	Preliminary	34.9	7.1	10.4
	Experimental	39.4	0.8	6.5
V				
Lard	Preliminary	42.7	2.5	5.8
	Experimental	62.5	2.7	3.7

[a] Preliminary—1 sample from each calf, taken at the end of the preliminary whole milk feeding period. Experimental—2 samples from each calf, taken at 3 and 4 wk. after change to the experimental diet.

data indicate that in most instances crude soybean oil and hydrogenated soybean oil effected the most striking changes in plasma polyunsaturated fatty acid values.

The percentages of each of the polyunsaturated fatty acids in the plasma total fatty acids were calculated and are summarized in Table 4. There was considerable variation among groups at the end of the preliminary period. The greatest changes during the experimental period were observed in the percentage of linoleic acid in groups fed crude soybean oil and lard, of linolenic acid percentage in the hydrogenated soybean oil group, and in the percentage of arachidonic acid in the group fed crude soybean oil.

DISCUSSION

Previous work *(20)* has shown that the blood plasma lipid levels in calves increase markedly during early post-natal life. In the present study increases in the levels of polyunsaturated fatty acids were observed. During the same period the percentage of linoleic acid in the total fatty acids increased, whereas arachidonic acid decreased. An explanation of these changes is not readily apparent. Inspection of earlier data *(20)* indicates certain changes in the ratios of the plasma lipids; the percentage of plasma phospholipids in the total lipids increased markedly and that of ester cholesterol increased to a lesser extent, whereas the percentage of neutral fat decreased from birth to 4 days of age. Despite these shifts in ratios, there was little change in the percentage of the total ester fatty acids in total plasma lipids. It appears, therefore, that the principal "carriers" of the polyunsaturated fatty acids (phospholipids and ester

cholesterol) were not as readily transferred from the maternal blood to the fetal blood as were the other plasma lipids.

It has been shown *(16)*, however, that polyunsaturated fatty acids (particularly the tetraenoic and hexaenoic) pass through the placenta into the fetal tissues in rabbits and humans when highly unsaturated oils, such as cod-liver oil or sesame oil, are administered near the end of gestation. In the present investigation no such oils were fed, but, although the levels of polyunsaturated fatty acids were low, the arachidonic acid levels in the newborn calf exceeded those for linoleic acid.

Consumption of colostrum and whole milk, which provided for the calves in Experiment I a supply of polyunsaturated fatty acid–containing lipids, resulted in marked increases in the plasma levels of linoleic and lesser increases in arachidonic acid values. The observed changes seem to reflect in part the polyunsaturated fatty acid content of the colostrum and milk. Deuel *(6)* has summarized several reports which indicate that milk from cows receiving various diets appears to contain somewhat more linoleic acid (3.6 to 4.5%) than is found in the colostral secretions. More recently, studies by Schaffer and Holm *(15)* indicate that milk fat contains 2.1 to 2.4% linoleic acid and 1.1 to 1.3% apparent linolenic acid. In the present study, the analyses by similar methods of milk fats fed in Experiment II (Table 2) show 1.3 to 2.2% linoleic acid, 0.3 to 0.6% linolenic acid, and 0.2% arachidonic acid.

Certain discrepancies in the relationship between specific polyunsaturated fatty acid contents of the lipids fed (Table 2) and the plasma levels of these acids after 3 and 4 weeks on the dietary regime (Experiment II) are not readily explainable. The lard-fed group received more arachidonic acid than any other group but the plasma level of this acid tended to decline during the experimental period, whereas the whole-milk group tended to maintain plasma levels of arachidonic acid on a somewhat lower intake. Moreover, the lard-fed group displayed only moderate increases in plasma linoleic acid even though the consumption of this acid was considerably higher than in groups fed whole milk, butter oil, and hydrogenated soybean oil.

The increase in the percentage of total plasma polyunsaturated fatty acids from the preliminary period to the mean of the third and fourth weeks of the experimental period was greatest for the groups fed crude soybean oil (37.7) and was followed in order by groups receiving lard (17.9), butter oil (6.4), whole milk (1.5), and hydrogenated soybean oil (–5.7). This order is the same as that for total percentage of polyunsaturated fatty acids in the dietary lipids (Table 2) used in this study, which suggests that the degree of polyunsaturation in the lipids consumed is reflected in changes in the total plasma polyunsaturated fatty acid level in the young calf. Wiese and Hansen *(19)* have reported a similar relation between dietary lipid and serum polyunsaturated fatty acids in dogs.

It has been reported *(4)* for the human that the level of plasma linoleic acid depends in large part upon alimentation, whereas both linolenic and arachidonic acid values are essentially constant constituents under normal conditions. In-

spection of the data in Tables 2 and 3 reveals that a somewhat similar situation exists in the young calf. The increases in plasma linoleic acid values were greatest for calves fed crude soybean oil, whereas decreases were found in calves fed hydrogenated soybean oil and butter oil.

It is interesting to note that the levels of plasma phospholipid and ester cholesterol in calves *(9)* correlate reasonably well with the values for the total plasma polyunsaturated fatty acids. These observations tend to confirm the belief that cholesterol esters and phospholipids act as "carriers" for the more highly unsaturated fatty acids *(10)*. However, additional study is needed to ascertain the types and quantities of polyunsaturated fatty acids that are esterified with neutral fats, phospholipids, and cholesterol esters in calf blood plasma.

SUMMARY

Five dairy calves were employed (in Experiment I) to study the early postnatal changes in blood plasma polyunsaturated fatty acids. At birth the values for plasma linoleic, linolenic, and arachidonic acids were 2.8, 0.6, and 3.2 mg/100 ml., respectively. During the following 4 days (calves with dams for 3 days and fed whole milk on fourth day) the values for these acids increased approximately tenfold, sixfold, and twofold, respectively, and the total fatty acids increased about fourfold.

In Experiment II, 15 newborn calves, divided into five comparable groups, were allowed to remain with their dams for 3 days and subsequently were fed whole milk for 2 weeks. During the following 4-week period one group continued to receive whole milk, and the other groups were fed reconstituted milks containing butter oil, crude soybean oil, hydrogenated soybean oil, and lard, respectively.

Plasma polyunsaturated fatty acids were determined at weekly intervals. Linoleic acid values markedly increased in the group fed crude soybean oil and lesser increases occurred in the whole milk and lard groups, whereas slight decreases were observed in groups fed butter oil and hydrogenated soybean oil. Changes in the linolenic acid values were not so conclusive; the butter oil group displayed the highest levels, whereas the group fed hydrogenated soybean oil decreased and was lowest throughout the experimental period. Calves fed milk fat (whole milk and butter oil) consistently maintained higher plasma arachidonic acid values than groups that received lard, crude soybean oil, and hydrogenated soybean oil. In general, the degree of polyunsaturation in the lipids consumed was reflected in changes in the total plasma polyunsaturated fatty acid level in the young calf.

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A HIGH ROUGHAGE SYSTEM FOR RAISING CALVES BASED ON THE EARLY DEVELOPMENT OF RUMEN FUNCTION. VII. UTILIZATION OF GRASS SILAGE, PASTURE, AND PELLETED ALFALFA MEAL

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Roughage plays an important part of the feeding of young calves. For several years studies have been in progress at the Ohio Experiment Station involving the feeding of various kinds of hay as the only roughage in a high roughage feeding system. The study herein reported was planned to obtain information on growth and rumen digestion when using pasture, grass-legume silage, and pelleted alfalfa meal as substitutes or partial substitutes for hay in the high roughage system. *Editor.*

A high roughage system of feeding calves, which is based on the early development of mature type rumen function, has been under investigation at the Ohio Agricultural Experiment Station for several years *(9, 10, 11, 17, 18, 19)*. In this system early rumen function is encouraged by feeding rations high in roughage with limited grain and the use of rumen inoculations consisting of fresh cud material. Most studies thus far reported have involved the feeding of various kinds of hay as the only roughage in the high roughage feeding system.

Previous work by Hibbs and Pounden *(10, 19)* has shown that it was possible for calves 6 weeks of age or younger to have an actively developed rumen and to utilize young tender pasture to good advantage, especially when it was used in conjunction with good quality hay. A report from New Zealand *(14)* indicated that legume-grass pasture, managed so as to provide young tender forage, was suitable as the sole roughage for calves. English workers *(1)*, using Shorthorn calves and utilizing pasture as the only feed after 8 weeks of age, obtained average daily gains in weight of 1.3 lb. during the 8- to 16-week age period. Digestion trials conducted by Conrad *et al. (5)* and Armstrong *et al. (2)* showed that calves digested young grass pasture efficiently as early as 8 to 9 weeks of age.

Considerable evidence has been accumulated which demonstrates that dehydrated alfalfa meal is an excellent source of high quality roughage for calves *(8)*. Dolge *et al. (7)* showed that calf performance was best when dehydrated alfalfa meal was fed at the 25% level with calf starter as compared to the 50% and 75% level and that these calves grew slightly better than a group of control calves fed good quality alfalfa hay free choice along with calf starter. Hibbs *et al. (11)* found that incorporating 5% alfalfa meal in the ration was an effective means of maintaining the carotene intake at a relatively high level in calves fed high roughage rations.

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The widespread use of grass-legume silage as a major roughage for dairy cows suggests that it could be used also for young calves as a source of good quality roughage as either a supplement or a substitute for hay. Results reported by Porter and Kesler *(16)* indicated that legume-grass silage could be used to replace alfalfa hay when fed with a dry calf starter. A subnormal growth response in dairy heifers fed alfalfa silage as the only forage and also when alfalfa silage was fed with limited amounts of hay was reported by Sykes *et al. (21)*. In the experiments to be reported here the objective was to obtain information on growth and rumen digestion when pasture, grass-legume silage, and pelleted alfalfa meal were used as substitutes or partial substitutes for hay in the high roughage system.

EXPERIMENTAL PROCEDURES

Experiment 1. Grass-legume silage free choice fed with limited alfalfa hay and grain to 12 weeks of age followed by Ladino clover pasture vs. barn feeding of alfalfa hay and grain from 12 to 26 weeks. Four groups of Jersey calves were used to study growth, efficiency of feed utilization, digestibility, the volatile fatty acids in the rumen juice, and blood sugar levels in calves fed grass-legume silage free choice along with limited amounts of hay and grain. In a factorial type experimental design two kinds of grass silage made from the same meadow crop, one preserved with 150 lb. of corn and cob meal per ton of green feed and a second preserved with 5 to 8 lb. of sulfur dioxide gas per ton, were fed with two grain mixtures of different protein content (14.5% and 19.9%). The grain mixtures consisted of ground shelled corn, ground oats, wheat bran, and soybean oil meal.

Whole milk was fed to 7 weeks of age at the rate of approximately 1 lb. of milk to 10 lb. of birth weight after a 3-day colostrum feeding period. Grass silage was fed free choice from 1 to 12 weeks of age. Good quality third-cutting alfalfa hay was offered along with the silage but was limited to a maximum daily amount of 1.5 lb. per calf. Grain feeding was begun at 5 weeks of age and regulated according to roughage intake so that each calf received 1 part grain mixture to 2 parts of hay equivalent consumed.

All calves were rumen inoculated as previously described *(11)* at the end of each week for 6 weeks. At the end of each week for 4 weeks, 250,000 U.S.P. units of vitamin A were given each calf in capsule form. All calves were weighed weekly, and records of daily feed consumption were kept.

Blood samples were drawn from the jugular vein weekly and analyzed for glucose by the method of Somogyi *(20)*. Rumen samples were taken by stomach tube at 12 weeks of age. Total steam volatile fatty acids were determined and chromatographic separations were made to determine the proportion of acetic, propionic, and butyric acids in the rumen juice. Chromatographic separations were made by the method of Bulen *et al. (3)*, as adapted for rumen juice by Linke *(12)*.

The male calves were placed in metabolism stalls during the 13th week. Determinations were made of dry matter, cellulose, and protein digestibility and

nitrogen retention. Total dry matter and nitrogen were determined by standard methods. Cellulose was determined by the method of Crampton and Maynard *(6)*.

The number of Jersey calves used in each group is shown in Table 1. Growth data of two Holstein heifer calves were obtained also and are included in Figure 1.

After the silage-feeding period the calves were divided at 12 to 13 weeks of age into two groups for the second phase of the experiment. Nine calves were assigned to the Ladino clover pasture group and seven control calves were assigned to the alfalfa hay group, which was fed and housed in the barn. Four ½-acre pasture plots seeded principally to Ladino clover were used in rotation for 1-week periods. The plots were clipped 1 month prior to turning in the calves and again after each 1-week pasture period throughout the summer. This rota-

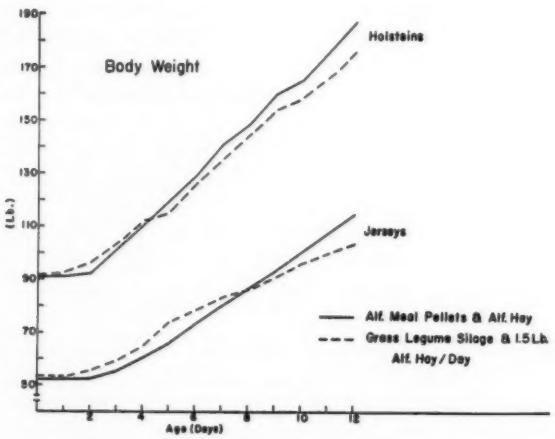

FIG. 1. Body weight changes to 12 weeks of age in calves in which the roughage fed was either grass legume silage or alfalfa meal pellets and alfalfa hay.

tion and clipping procedure provided young forage with 1-month growth for each pasture period. The pasture calves were fed 2 lb. of whole oats per head daily as the only supplemental ration. The control calves were given alfalfa hay free choice, and the grain mixture containing 14.5% protein was limited so that the calves consumed a 2:1 ratio of hay to grain.

Growth, feed consumption (barn-fed calves), digestibility, rumen volatile fatty acids, and blood sugar were determined.

Experiment 2. Pelleted alfalfa meal mixed in equal parts with grain fed free choice with alfalfa hay. In this experiment a study was made of the use of dehydrated alfalfa meal pellets as a hay quality stabilizer in high roughage fed calves. Ten Jersey and four Holstein calves were included.

Pelleted dehydrated alfalfa meal (approximately 17.0% protein) was mixed in equal parts by weight with the grain mixture indicated below (approximately

TABLE 1

The performance of Jersey calves fed grass silages and pelleted alfalfa meal supplemented with a simplified grain mixture and alfalfa hay

	Experiment 1				Experiment 2
	Sulfur dioxide preserved silage		Corn and cob meal preserved silage		Alfalfa meal pellets, grain and hay
Protein in grain *(%)*	14.5	19.9	14.5	19.9	15.0
No. of calves	4	6	4	4	10
Whole milk *(lb.)*	297.0	288.0	281.0	282.0	255.5
Grass-legume silage *(lb.)*	70.3	74.9	45.4	51.6	—
Alfalfa hay *(lb.)*	53.6	59.9	54.3	51.1	64.1
Pelleted alfalfa meal *(lb.)*					39.6
Grain *(lb.)*	26.3	30.5	22.0	25.5	49.5
TDN, 12 wk. *(lb.)*[a]	106.8	112.9	96.3	104.3	132.8
Weight gain, 12 wk. *(lb.)*[b]	50.0 ± 8.4	55.0 ± 9.2	46.0 ± 12.4	46.0 ± 8.5	62.5 ± 10.1
TDN/lb gain, 12 wk. *(lb.)*[a]	2.14	2.05	2.09	2.26	2.12
Weight gain, 8-12 wk. *(lb.)*[b]	14.0 ± 5.8	17.0 ± 5.6	15.0 ± 10.0	17.0 ± 7.6	35.5 ± 7.7
TDN, 8-12 wk. *(lb.)*[a]	52.9	52.9	41.6	43.0	75.8
TDN/lb gain, 8-12 wk. *(lb.)*[a]	3.78	3.11	2.77	2.54	2.14
Dry matter digested *(%)*	66.1	62.2	67.7	67.3	64.3
Cellulose digested *(%)*	56.9	56.4	55.8	59.5	43.7
Protein digested *(%)*	69.3	66.3	70.2	68.0	70.1
Nitrogen retained *(g/d/cwt)*	6.69	4.20	7.90	6.07	17.80

[a] TDN calculated from Morrison's *(15)* appendix, Table 1.
[b] Average weight gain for each group ± the standard deviation.

15% protein) and fed free choice along with alfalfa hay free choice to 12 weeks of age:

	lb.
Dehydrated alfalfa meal, pelleted	1,000
Coarse cracked corn	466
Crimped oats	240
Soybean oil meal (flaked)	140
Cane molasses	100
Dicalcium phosphate	40
Iodized salt	10
Vitamin A feeding oil, 5,000 U.S.P. units per gram	4
D-activated plant sterol, 4,000,000 U.S.P. units per pound	¼

Cud inoculations were given as in Experiment 1, and milk was fed at the rate of 1 lb. per 10 lb. of birth weight. All calves were weighed at weekly intervals, and daily feed consumption records were kept. Digestibility and nitrogen retention data were obtained during the 13th week with the male calves.

Periodically, blood samples were obtained for blood sugar determinations, and rumen samples were taken for volatile fatty acid determinations.

RESULTS AND DISCUSSION

Comparisons of growth, feed consumption, and efficiency of feed utilization for the first 12 weeks among the four groups of grass silage-fed calves in Experiment 1 and the alfalfa meal–alfalfa hay fed calves in Experiment 2 are summarized in Table 1. Regardless of the level of protein in the ration, the calves fed sulfur dioxide–preserved silage ate more silage and made greater gains to 12 weeks of age but utilized TDN less efficiently during the 8-12 weeks age period than calves fed corn-preserved grass silage. The comparatively poor average performance of the grass silage–fed calves is indicated by their growth after milk was removed from the ration (8 to 12 weeks) compared with that of calves fed the ration composed of alfalfa meal, grain, and alfalfa hay (Experiment 2), as shown in Table 1 and Figure 1. The latter group gained more than twice as much during the 8-12 week age period as the calves fed grass silage (Table 1). It can be noted that the growth curves of both Holstein and Jersey calves used in Experiments 1 and 2 (Figure 1) are higher for the alfalfa meal–alfalfa hay fed calves (Experiment 2) than for silage-fed calves. During the 8-12 weeks age period the sulfur dioxide–grass silage fed groups consumed more TDN but used the nutrients less efficiently than the calves fed the corn-preserved silage (Table 1). Weight gains were the same for the two types of silage. The slightly higher weight gains observed in the groups receiving the higher protein grain mixture were considered to be insignificant.

It appears from the results in Table 1 and routine observations of the calves' eating habits that the sulfur dioxide–grass silage used in this experiment was

more palatable than the corn-preserved grass silage. Considerable variation in the acceptability of both silages by the calves was observed. This doubtless accounted for much of the relatively poor performance of the silage-fed calves.

Selective eating was encountered in Experiment 2 when the pelleted alfalfa meal mixed with equal parts of grain was fed free choice with alfalfa hay. Some calves chose to eat mostly alfalfa hay, others sorted out the grain from the pellets, and still others preferred the pelleted alfalfa meal. However, inspection of Table 1 shows that the group consumed on the average a 2:1 ratio of roughage to grain.

The per cent dry matter, cellulose, and protein digested was similar for all groups except that the calves fed alfalfa meal–alfalfa hay ration digested a lower percentage of cellulose than the grass silage–fed calves. Concurrent digestibility studies of the various roughages fed separately with grain indicated that this lower cellulose digestibility was due to the finely ground condition of the

TABLE 2

Comparison of Ladino clover pasture and alfalfa hay for growth, feed consumption, and digestion during the 18-26 weeks age period

	Ladino clover pasture[a]	Alfalfa hay[b]
No. of calves	9	7
Hay *(lb.)*	—	409.1
Pasture *(d.)*	63	—
Grain *(lb.)*	126.0	132.7
Weight gain, 18-26 wk. *(lb.)*	102.0 ± 10.8	86.0 ± 22.1
Ave. daily gain, 18-26 wk. *(lb.)*	1.62	1.37
Dry matter digested *(%)*	64.2	65.4
Cellulose digested *(%)*	64.8	67.1
Protein digested *(%)*	57.1	66.3

[a] Fed 2 lb. of whole oats per head daily.

[b] Fed a 2:1 ratio of hay to grain.

alfalfa meal. Daily nitrogen retention was much greater in Experiment 2, in which alfalfa hay and alfalfa meal were fed as the roughage (Table 1).

A comparison of the results obtained from the pasture versus the barn fed calves in Experiment 1 is presented in Table 2. This shows that calves provided with Ladino clover pasture plus 2 lb. of oats daily grew faster than the similar group fed a mixed grass–alfalfa hay plus a grain mixture in a 2:1 ratio. It should be noted that the hay available for this comparison varied markedly in quality; also, several calves failed to eat their allotted quantity of grain. The pasture-fed calves gained 1.62 lb. per day during the 18-26 weeks age period, which compares well to the 1.51-1.59 lb. range for daily gains given in the Beltsville growth standards *(13)* for Jersey heifers of this age. Digestibility trials were conducted in the latter part of July by using clippings mowed daily. The per cent dry matter, cellulose, and protein digested was less in the pasture-fed calves at this time than in those fed the 2:1 hay to grain ratio.

Thirteen cases of bloat, none of which had to be treated, were noted in the pasture group during the experiment. All were observed in four individuals.

TABLE 3

Volatile fatty acid content of rumen juice from calves fed various types and combinations of roughage[a]

	Grass-legume silage plus alfalfa hay (Expt. 1)	Pelleted alfalfa meal plus alfalfa hay (Expt. 2)	Ladino clover pasture (Expt. 1)	Alfalfa hay (Expt. 1)
No. of calves	16	14	9	5
Age *(wk.)*	12	12	18	18
Steam volatile acid *(meq/l)*[b]	97.7 ± 11.4	115.1 ± 13.7	96.9 ± 9.5	103.0 ± 5.8
Acetic acid *(g/l)*[b]	2.61 ± .55	3.99 ± .57	2.25 ± .44	3.61 ± .24
Acetic acid *(%)*	66.6	67.6	64.9	65.5
Propionic acid *(g/l)*[b]	0.81 ± .27	1.55 ± .31	0.75 ± .18	1.48 ± .38
Propionic acid *(%)*	16.9	20.6	17.5	21.4
Butyric acid *(g/l)*[b]	1.02 ± .30	1.03 ± .34	.90 ± .27	1.06 ± .12
Butyric acid *(%)*	16.5	11.6	17.6	13.1
Total volatile acids *(g/l)*[c]	4.42	6.57	3.90	6.15

[a] Grains fed as previously described.
[b] Values given equal average for group ± the standard deviation.
[c] Total volatile acids equal acetic, propionic, and butyric summed.

Results of steam distilling and chromatographically separating the volatile fatty acids in rumen juice from the calves in Experiments 1 and 2 are summarized in Table 3. The range in proportion of volatile fatty acids in the rumen juice from calves on various rations in these experiments is similar to that found by Card and Schultz *(4)* in mature cattle fed various roughages, including grass silage, pasture, and hay. Both total steam distilled and chromatographically separated volatile fatty acids were highest when alfalfa meal and/or alfalfa hay was used as the roughage and lowest when grass silage plus alfalfa hay or Ladino clover pasture was used. Although the proportion of acetic acid was approximately the same for all types of roughage, the total quantity of acetic acid was much greater when alfalfa was used exclusively as the roughage. The concentration of propionic acid in the rumen juice of the alfalfa-fed calves was approximately twice that found in the pasture and silage-fed calves. On the other hand, the proportion of butyric acid was highest when silage and pasture were used; however, the quantity per liter of rumen juice did not vary markedly among the groups. Thus, the variations in proportion of acetic, propionic, and butyric acids among the various groups were caused largely by differences in the concentration of acetic and propionic acid in the rumen juice.

The blood sugar level of the calves fed grass silage declined sharply to 45-50 mg. % after reduction and removal of milk from the diet, whereas the calves fed alfalfa meal and alfalfa hay maintained a blood sugar level of 55-60 mg. % during this period (Figure 2). Also, a steady increase to 55-60 mg. % at 18 weeks of age was observed in the grass silage–fed calves following the transition period in which roughage was changed to either mixed alfalfa–grass hay or Ladino clover pasture at 12-14 weeks of age (Figure 2).

It was noted with particular interest that the relatively poor growth, decreased efficiency of feed utilization, and low TDN intake of the silage-fed calves

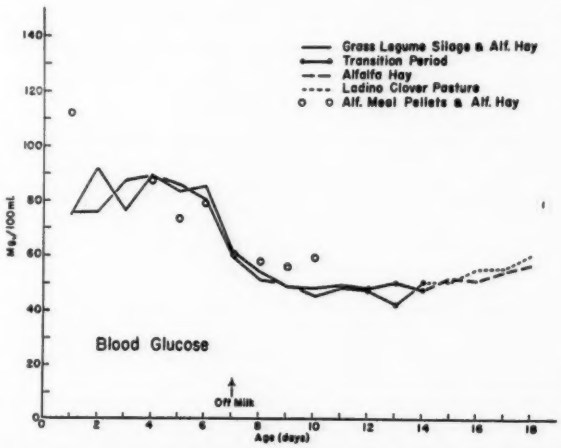

FIG. 2. Changes in blood glucose in calves fed various types of roughage.

were accompanied by low blood sugar and a relatively low level of acetic and propionic acid in the rumen juice.

SUMMARY AND CONCLUSIONS

Growth, feed consumption, digestibility and efficiency of feed utilization, volatile fatty acids in the rumen juice, and blood sugar levels were used as criteria in comparing various roughages for calf feeding. In the first experiment, 20 rumen-inoculated calves (18 Jerseys and two Holsteins) were fed grass legume silage free choice along with limited hay and grain to 12 weeks of age. In a second experiment, 14 calves (10 Jerseys, four Holsteins) were fed free choice pelleted alfalfa meal and a coarse grain mixture combined in a 1:1 ratio plus alfalfa hay free choice. Sixteen of the calves fed grass silage to 12 weeks of age were used during the 13-26 weeks age period to compare those fed Ladino clover pasture with those fed hay in the barn at 2:1 ratio of hay to grain.

The calves fed grass silage grew less, consumed less TDN, and made less efficient gains than the calves fed the pelleted alfalfa meal–alfalfa hay ration.

Calves feeding on Ladino clover pasture and 2 lb. of oats daily gained more rapidly from 18-26 weeks than barn-fed calves receiving a 2:1 ratio of hay to grain. The results indicated that good legume pasture may be substited for hay in the high roughage system after the calves are 3 months of age.

Total steam volatile fatty acids and acetic and propionic acid were highest in calves fed alfalfa hay as the only roughage and lowest in calves fed grass silage or pasture. The widest differences were observed in the concentration of propionic acid. The quantity of butyric acid in rumen juice was approximately the same for all types of roughages used.

Blood sugar levels declined to 45-50 mg. % in the silage-fed calves after removal of milk from the ration compared to 55-60 mg. % in the calves fed pelleted alfalfa meal with alfalfa hay. After changing the calves from grass silage to hay or Ladino clover pasture, blood sugar levels increased.

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PROCEEDINGS OF THE FIFTY-FIRST ANNUAL MEETING OF THE AMERICAN DAIRY SCIENCE ASSOCIATION

June 18-21, 1956

H. F. JUDKINS, *Secretary-Treasurer*

The American Dairy Science Association met for the opening session of its Golden Jubilee Meeting in the beautiful auditorium of the University of Connecticut, Storrs, Conn. The meeting opened with the singing of the National Anthem, followed by the invocation and an address of welcome by Dean W. B. Young of the University of Connecticut. Dr. W. A. Cowan, head of the Animal Industry Department, University of Connecticut, acting as presiding officer, then introduced President Ira A. Gould, who conducted the Golden Jubilee Ceremony.

GOLDEN JUBILEE CEREMONY

I presume it would be appropriate if I were to begin this brief ceremony by saying, "WELL --WE MADE IT!" And by this phrase I refer to the fact that after its good times and bad, its problems and its joys, our Association has come finally to this historical moment—The Golden Jubilee Meeting.

This is certainly a far cry from the original meeting 50 years ago. At that time—in 1906—only 18 men gathered at the University of Illinois to found the Association. They did this very simply. They merely adopted a constitution of only 93 words; they established annual dues of 50 cents; and they suggested annual meetings be held.

At this time—50 years later—we might well speculate as to what visions even the most optimistic of these 18 charter members had relative to the future of their "brain child."

Could they have envisioned the founding of the *Journal of Dairy Science* which came 11 years later? Could they have realized that such a Journal would have world-wide distribution by the 50th anniversary of the Association—and would be recognized as the outstanding scientific publication in the dairy field?

Could they have dreamed of regular summer meetings—which began 21 years later at Michigan? Could they have imagined that these summer meetings would become an effective—and traditional—family-style affair—and the envy of many other groups? Could they have anticipated these meetings would have an attendance which is evident today?

Could they have imagined that by its 50th birthday the Association would have grown in membership to more than 2,000 and that it would be accepted as the outstanding scientific and educational organization in the dairy industry?

Could they have anticipated that the members of this Association would be largely responsible for the research—and the classroom teaching—and the extension education—and the development of industry leaders—for the entire dairy industry?

Could they have believed that this Association, established largely for academic persons, would become the organization for all professional dairymen, and that more than one-third of its members would be from the nonacademic areas of the industry?

Truly, it is expecting too much that the charter members could have foreseen these and many other developments with which the Association has been, or is now, involved. However, their major tasks were done well—to found the Association—and to see it through its infancy.

There are many events of importance which could be recounted relative to the history of our Association, but a summation of the history is in your morning program and a more complete history is in the June issue of the Journal. Suffice to say that over the years our Association has grown in size, in scope, and in influence. We would not be stretching the truth by saying that the American Dairy Science Association could well be called the "International" Dairy Science Association, because its influence extends beyond the borders of our land.

As one looks to the history of our Association and gains an appreciation of what has been achieved, he recognizes that all such achievements did not just happen but are truly the results of the work of men.

Obviously, it is not possible to give credit to all who have helped bring our Association to its present state. However, we can use this occasion to give credit and pay tribute to those 18 men who had the courage and vision to organize this Association 50 years ago. This we want to do!

The 18 charter members are listed on your program. Five of these men are still living—

C. F. Doane, Carl Lee, Otto F. Hunziker, C. C. Hayden, and E. S. Guthrie. Mr. Thom passed away the 24th of May—after the printed program went to press—and has been buried here in Storrs, where he served as a staff member in his younger days. Of the five living charter members, only one could be present today. Those who could not be present have all written to extend greetings and best wishes for a successful meeting. To typify the thinking and philosophy of these men, I would read for you excerpts from a letter received from C. F. Doane of Oregon. He writes:

"I feel, indeed, very thankful for the very cordial invitation to attend the 50th anniversary meeting of the Association—but it is a long journey from Oregon to Connecticut and —while my 83 years do not rest very heavily on me—it would not seem prudent to undertake such a journey, much as I would like to attend the sessions of the Association. Much of the discussions would be beyond me—but it would be interesting to mingle with the men and sort of size up with a prejudiced eye the caliber of the men as compared to the men with whom I once worked. I know that I would find them much more highly trained.

"The record does not show that much work of a scientific nature along dairy lines had been done prior to 1906—but we had a vision —although not a very definite vision—of possibilities. (We had) reason for hoping that dairying might (become) a science instead of an art. Some could not see this—but the increasing volume of material handled (now) by the Association and the *Journal* emphasizes the fact that, though we did not have much to offer, we were starting something really worthwhile.

"I certainly appreciate the honors given the charter members of the Association. Some of the younger members may live to see the 100th anniversary of the Association. It would indeed be foolish to limit by prediction what then may be.

Sincerely, C. F. Doane."

Today we wish to pay tribute to E. S. Guthrie, Professor Emeritus of Cornell University, as the sole representative of the living charter members. We shall ask Dr. Trout, the Association's historian, to bring Dr. and Mrs. Guthrie forward.

Mrs. Guthrie, behind every good and great man—a fine and wonderful woman. We know you have been an inspiration to your husband over the years, and we are glad you could stand with him today. We present to you this orchid corsage as a token of this occasion.

Professor Guthrie, we want you to know we are proud to have a person like you in our Association. We feel fortunate that men such as you were available in 1906 to get our Association organized and started on its way. We are particularly grateful to you for the high interest and devotion given to our Association since its inception, for the leadership you have displayed in the offices held, and for the inspiration you have been to all of us who have known you. We feel that by this ceremony we in the Association are not only honoring you but that you, in turn, are honoring us. Therefore, as a token of our esteem and affection and appreciation, and—on behalf of the members of our Association and by authority of the Executive Board—I am pleased to present to you this plaque.

(CITATION ON PLAQUE)
To
E. S. Guthrie
—
CHARTER MEMBER
American Dairy Science Association
—
In appreciation of unselfish devotion and loyalty to 50 years of Dairy Science
—
A.D.S.A.
Golden Anniversary
1906-1956

Similar plaques are going tc other living charter members.

We also want to pay tribute today to another pioneer—the person who was responsible for bringing into being the *Journal of Dairy Science.* Therefore, we pay tribute to Professor J. H. Frandsen of Massachusetts—the originator and first editor of the Journal. Dr. Trout, please present Professor and Mrs. Frandsen.

Mrs. Frandsen, yours has been a life of service and devotion and inspiration to your husband. We know you helped him directly as he undertook the editorship of the Journal some 39 years ago. It is fitting that you can share in this experience with him today. We present this orchid corsage as a token of this occasion.

Professor Frandsen, the Association owes a great debt to you. The records reveal it was through your vision and perseverance that the *Journal of Dairy Science* was founded. Furthermore, history reveals that the burden you

assumed as the first editor of the Journal was tremendous and that you operated under a great handicap. The present-day success of the Journal—and the reputation it holds—is a monument to your services. Not only did you serve in this connection, but you have been an enthusiastic worker, leader, and contributor in many Association affairs. We are pleased and honored that we have this opportunity to say, "Thank you." As a token of our esteem and appreciation, I present to you this plaque on behalf of our members and on authority of the Executive Bord.

(CITATION ON PLAQUE)
To
Julius H. Frandsen
—
FOUNDER AND FIRST EDITOR
Journal of Dairy Science
1917
—
In grateful recognition of his service to
Dairy Science in America
—
A.D.S.A.
Golden Anniversary
1906-1956

During this ceremony several references were made to the history of our Association. Such a history has come into being as the result of a tremendous amount of work by our historian, Dr. G. M. Trout. A reduced version of this history is in the June issue of the Journal—but probably few of you will have the opportunity to see the original 125-page document which was prepared. To see it, one appreciates the weeks of research and writing which were necessary in its preparation.

Dr. Trout, when the Executive Board invited you to serve as historian of the Association and to prepare a 50-year history of its development, it did not realize the tremendous task which was involved. Certainly, too, as you labored in the preparation of the document there must have been times when you questioned the advisability of doing the job completely. The Executive Board and the members of our Association are most grateful to you for the magnificent contribution you have made. Therefore, for our membership and on instruction of the Executive Board, I am pleased to present to you this certificate as a token of our appreciation.

Introduction of 2,000th member:

We have had various special activities this year, but one major one was the membership campaign—headed by Lyman Rich of Utah. A membership goal was set of 2,000 members—about 250 more than the previous high. This goal was reached, and as a symbol of this achievement the person who was the 2,000th member is with us to be recognized. He is a Texan, living in Houston and employed by The Borden Company. He was flown in by his company for this occasion. I present Woodrow W. Echols.

Now I would ask that you look with me not at the future but at the present. I would remind you that men are still responsible for the welfare of our Association, just as in the past, and that you elect certain persons by democratic process to watch out for your interests. Therefore, it is fitting I present to you some persons who are giving the leadership in your Association today. (The Association officers, division chairmen, and members of the program committee, who were seated on the platform, were then introduced.)

Our Association has met on 17 different campuses since its beginning, but it is especially appropriate that we have this Golden Jubilee meeting in Connecticut. Connecticut is steeped in history and tradition, as one of the pioneer states of our land. Here at the University of Connecticut, they are celebrating their Diamond Jubilee, and we would be remiss if we did not give formal recognition to this fact. Certainly, our Association is fortunate in being privileged to come to this fine University and to this historical state for our 50th anniversary meeting.

President Jorgensen, on behalf of our members and officers I express to you our sincere thanks for your kind invitation to meet with you. Also, I express our appreciation for the wonderful cooperation which has been given us by Professor Cowan, Professor Johnson, and other members of this group. I am sure our Association has never had a meeting in which the plans were better laid and where members of the host institution were more interested in the welfare of the visitors. We are sure that our stay here will be something we shall remember with great pleasure for many years to come.

PRESIDENTIAL ADDRESS

One year after the founding of our Association the second annual meeting was held in Chicago. Twenty-one members attended the banquet, which was featured by a presidential

address by President R. A. Pearson. Here, then, was the first presidential address of our group. As we look back on this occasion, I believe we can assume that Dr. Pearson never anticipated that his initial effort that night would serve as an excuse by the presidents for the next 48 years to give presidential addresses.

I. A. Gould

Nevertheless, this has been the case. We now have a tradition established, and it is not my desire, on this Golden Jubilee occasion, to deviate from it. However, I do take courage in following this established custom, since, over the years, our Association has grown and prospered even in the face of these annual addresses. Therefore, I am assuming—and hopefully so—that today's presentation will cause no adverse change in this normal trend.

In considering this matter of presidential addresses, I am reminded of the comment by the wag who said that "If all of the presidents of these associations who felt impelled to give presidential addresses were laid end to end—it would be a good thing."

On this historical occasion in our Association and in our few minutes together, we have three possible choices: We may spend our time examining our past history—we may review our present situation—we may look ahead. I prefer the latter.

As to the past, we have paid tribute today to some of our pioneers and have called attention to the published history of our Association. As for the present, this year's business meeting will deal specifically with the current program. Therefore, it appears logical that here today we consider the years ahead—where we and the Association must spend the remainder of our lives.

And as we consider the future we are faced immediately with major problems—and these major problems require major decisions. The question is, "How are we going to evaluate these decisions?"

LIN YUTANG, the Chinese philosopher, deals with this in the telling of an ancient parable of the old Chinese farmer living in an abandoned fort with his son. The old man's horse wandered away one night, and the next day the neighbors came to express their regrets at this misfortune. But the old farmer said, "How do you know this is ill fortune?" A few days later the horse came home bringing with him several wild horses, and the neighbors came, helped him to corral the wild horses, and congratulated him on his good fortune. Again, the old man asked, "How do you know this is good fortune?" A few weeks later the old man's son was riding one of these wild horses and was thrown, breaking his leg. Again the neighbors appeared and were ready to weep with him over his bad luck. But with a smile the old man said, "How do you know it is bad luck?" In a short time, a Chinese war lord came along conscripting every able-bodied man for his private war. Since the old man's son was a cripple, he was not taken. Once more the neighbors came to share in the joy of his good luck, and once more the old man said, "How do you know this is good luck?"

Well, this could go on and on, as Chinese stories sometimes do—it has no end.

But I use this to illustrate the point that in arriving at decisions we should give thought to their lasting value—their long-range effect—and not be unduly influenced by that which is temporarily expedient.

In our brief discussion today, I would like to have you look with me at some major approaches or pathways which lead to tomorrow's responsibilities and goals.

The first of these pathways which I suggest for your consideration is the Pathway of Experience. This pathway is the one which allows us to build on what has gone before. It connects the past with the present.

The story is told of two men walking across a field—when they were chased by a bull. One of the men climbed a tree and the other jumped into a hole in the ground. The bull gave up the chase and started to leave—when the man from the hole came dashing out. The bull returned to the charge and the man again jumped into the hole. This process was repeated several times—with the man in the ground coming out and the bull chasing him back into the hole at frequent intervals. Finally—the man in the tree became exasperated and called out, "You crazy fool! Why don't you stay in the hole and let the bull go away?" "Crazy fool yourself!" the man on the ground shouted back. "There's a bear in this hole!"

We need to have the proper perspective—the right point of view—if we expect to make the proper suggestions and arrive at the right

decisions. Such a perspective can be gained for our tomorrow's planning on the basis of the experiences and events of the past.

An industrial executive[1] recently said, "If we could save only 1% of the professional time at our disposal by better literature searching, it would be worth $15 to $20 million annually now—and much more in years to come."

In other words, time is costly and precious. But we can achieve a saving in energy and time, and obtain a greater efficiency, by capitalizing on the information already available.

And yet—how carefully have we determined the events of history which relate specifically to our own particular job—the knowledge of which might help each of us come more nearly to achieving our full potential of productivity?

We pride ourselves for our research accomplishments, but if we search out the reports of earlier studies on the same subjects we are shocked and humbled to find out just how much was known before our contributions were made. I have had the opportunity this year to read of the research conducted at the time our Association was started, and I was struck with the soundness of the principles which resulted. They are as applicable now as then. It is of interest to note, too, that in this 50-year interim numerous other researches have been conducted —over the very same ground—with little basic additional information created in many cases. The same inference may be drawn for our classroom and extension teaching.

So we may ask ourselves: "How often have we repeated work which has already been done and, by so doing, contributed little or nothing in additional knowledge?" "How often have we discovered something which was already known or made mistakes which had previously been made?" "Have we utilized past experiences and previous findings to full advantage in order to move more quickly into virgin fields of research —or into new programs of education—or into new endeavors of industry?"

Our Association also can capitalize on experience in building for the future. Its history is rich with valuable information which should be reviewed frequently and thoroughly—and appropriate action taken accordingly.

Furthermore, in our organization we have many men whom we may call "elder statesmen" —men with years of experience and background in our Association and in industry work. And there are many capable younger members with varying backgrounds and imbued with enthusiasm. Unfortunately, we have made too little use of the counsel and guidance and experiences of all of these men. Let us hope that this rich talent will be utilized to fuller advantage.

It is said "Experience is the best teacher." The question we face is, "How can we use this teacher most effectively as we plan for tomorrow's needs?"

The second pathway I suggest is the Pathway of Expansion. Our Association is faced with the need for a dynamic "3-D" expansion—expansion in depth, expansion in breadth or scope, and expansion in diversity of influence.

Since our Association began with its membership largely in the academic field, the belief has prevailed in some circles that our group operates in an atmosphere of isolationism and selectivity—that we are not particularly concerned with nor interested in the basic industry-wide problems.

Perhaps this erroneous yet persisting belief is why our Association has been ignored by industry-wide groups in the development of programs of general concern. Perhaps this is why our Association and its members involved in education have been subjected to considerable criticism for being uninformed or nonactive in industry matters outside of the classroom or away from the campus. In a sense, this seems to be somewhat of a paradox: We are criticized by some commercial leaders for not being a part of industry-wide activities—but at the same time, as an Association, we are not invited or privileged to become a more active participant.

This appears to be about as illogical as the husband who had not kissed his wife for 10 years—and then shot the man who did!

In this entire matter of remaining too far separated from industry-wide problems, we must face the facts and realize our Association has not been blameless. Although we have not fostered, intentionally, this feeling of aloofness, we have done far too little to discourage it. And discourage it we must—if our Association is to play its rightful and important role in our complex industry!

What are some possible steps to take to expand our Association in breadth and influence?

The first step to consider is that of developing and maintaining effective communications with those outside our Association. Communication means literally "to inform" and so we may consider how we can better inform others of what this Association is doing—and can do if given the full chance.

Communication involves public relations—and public relations is simply doing a good job and letting people know about it. Other Associations in our industry—and certainly many

[1] T. A. Vaughn, Colgate-Palmolive Co., before the Industrial Economics Conference.

dairy leaders—are not fully informed as to what this Association is, what it does, and its tremendous influence on the destiny of the dairy industry through research and education.

Communication is not always simple and it usually requires a receptive ear if the correct understanding is to be achieved.

> The incident is told of the member of the House of Representatives in Washington who was awakened from a deep sleep one night by his wife who said, "John! Awake! There's a thief in the house!" He sleepily opened one eye and said, "Oh, no, Mary! There may be a thief in the Senate—but none in the House!"

It would seem that one of the basic responsibilities of our group is to interpret research findings in terms of application and disseminate these interpretations so that they may be utilized by the entire Industry. Although research for research's sake has merit and should be encouraged, nevertheless, science in a vacuum is of no benefit to an industry nor to the people who comprise it.

Another step our Association may take toward expansion is to consider itself as *the professional* organization of the dairy industry—as well as the official group for science and education. On this basis, all persons with a professional background in dairying should be encouraged to belong and thus place our Association in a stronger position to render greater service to the industry.

Furthermore, we could well accept the responsibility to instil into the minds of our dairy school graduates that they are "professional" dairymen and it is expected that they should be members of this organization.

Our Association must extend itself in the days to come to assume a more dynamic role in inter-association affairs—to work closely with other organized groups of our Industry. There are several important groups with which our Association should be officially involved in programs of great importance—but such is not now the case. We will wish to break down whatever imaginary barrier exists—and make ourselves available for fuller cooperation than has existed to date.

In our industry-wide relationship, we shall need to demonstrate real leadership in connection with student recruitment, to speak out strongly in respect to the commercial industry's treatment of college graduates, and to lay down principles by which the professional dairy graduate might expect to receive the opportunity to utilize his abilities to the maximum after graduation.

We have already offered the services of our Association in producing a colored sound movie which would be an effective public relations vehicle for the industry, as well as a student recruitment tool. Efforts in this connection should be continued and intensified.

A new and specific project our Association should consider initiating is an annual national event which may be designated as "Dairy Science Progress Week." This would be designed as an industry-wide project for the purpose of informing the public of the contributions of science to the progress of the dairy industry and—thus—to the well-being of the nation. Perhaps no group has more to offer in this connection than ours, but it will require careful planning and full industry cooperation if such a venture is to be successful.

Among all of the pathways to tomorrow we may consider taking—none offers greater challenge than the Pathway of Education!

In education we are a part of the general area of physical and biological sciences, and thus we are intimately involved with the current critical technical manpower shortage. We need, therefore, to take stock of this situation and determine what role we as an Association and as individuals may play.

The present low enrollment in our dairy manufacturing departments and in our graduate programs, the keen competition which exists among all science areas for superior secondary-school graduates, and the great demands by industrial groups and scientific organizations for men of management or for research place a heavy responsibility on those of us in education.

There is little doubt that one of our first responsibilities would be to examine our curricula, our facilities, our personnel, and our teaching philosophy to determine whether or not we are doing the job which needs to be done.

Perhaps as a beginning, we should establish firmly the true purpose of our educational program—and re-define our educational objectives. This applies both to classroom and extension education. This applies also to our Association. Never was the opportunity greater—and the demand more urgent—for our Association to assume the educational leadership of the Industry.

In our educational institutions we shall need to reaffirm our stand that the intent of a four-year curriculum is to "educate" and not to "train." We shall need to cast aside the concept, which too often prevails, that we are engaged principally in "vocational" training. It is true our curricula are developed about a

subject area, but the scope should extend far beyond the vocational aspect.

The four-year program in our area should be designed to educate a student as fully as in any other area—to produce if we can a "universal" man with our University program. Our educational program can be as much or as little as we want to make it. It will be only as scholarly as the college staff members themselves. It will be as deep or as shallow as the philosophy of the department. In some manner we in education need to stress less the "how to do" and more the basic principles of "why." We need to demand of the student less manual dexterity and more mental agility. We need to arouse his curiosity, to provoke his thinking, to create a desire on his part to continue to grow mentally following graduation. We need to gear our teaching for its long-range effectiveness—on the basis of its worth to the student 15 and 20 years after his graduation.

The demand for better qualified graduates necessitates a continuous program of improvement in our teaching methods. We are brought to the realization that we cannot depend upon textbooks as sources of current information for advanced undergraduates but that we need to utilize the *Journal of Dairy Science* for this purpose. Such usage will keep the student aware of current research and of the men who are doing it. This creates a natural situation for all junior and senior students to become Student Affiliate members of the Association. If junior and senior students cannot read the Journal intelligently, then there has been something wrong with their educational program during the first two years. And as for cost, the student affiliate membership costs less than a standard textbook—and has far more educational worth.

As we examine the situation in other fields and read the comments made by educators who are concerned with the technical-manpower shortage, it is clearly evident that these leaders are in agreement that we should not sacrifice the rigidity of our educational program for "quantity" of students. Instead, they are stressing that we should strive even more for "quality" of student. Leading universities of the country, which have made critical appraisals of curricula, have held firm to the belief that a strong science foundation is of paramount importance, and under no circumstances do they contemplate weakening this. Instead, they are expanding the curricula by incorporating fringe subjects or so-called broadening courses—a practice worthy of our consideration.

These observations should serve as a guide to us in our own field where temptation exists to popularize our courses—perhaps to be swayed by the emotion of the moment—and to temporize our science programs with the view of increasing the enrollment. Ours is basically a science area and it seems logical that we should stay steadfast with that which constitutes a sound and realistic program. Numerous leading industrial executives have graduated from rigorous science programs. In such courses they have been subjected to mental discipline made possible by mathematics and science and thus have obtained the basis for logical reasoning and sound decisions. This should be our objective as well.

And in this educational program we shall need to find out also what our qualified industry leaders really want in the way of a curriculum and—of greater importance—to find out what the industry plans to do with the superior college graduate. There are few companies in the dairy field which have any semblance of a personnel training and development program.

Although the shortage of "quality" undergraduate students in dairying has been well publicized, little attention has been given to the graduate student situation. In some respects, this is an even more critical situation since we are failing to replenish the supply of well-trained dairy scientists and to have a backlog of these scientists for the ever-expanding needs of educational institutions, governmental agencies, and the food industries.

The great need for scientists has resulted because of the tremendous growth of research. In 1941, approximately 900 million dollars were spent on all types of research, whereas in 1955 the annual expenditure was 5 billion dollars. This is expected to increase about 30% by 1959. We are now short about 20,000 scientists, and it has been estimated that this shortage will rise another 30,000 by 1960. Only about 5,000 persons graduated last year with doctoral degrees in the natural sciences—an area which is considered as a prerequisite for research work. It is estimated that the number of graduates with Ph.D. degrees could be doubled at the present time without completely filling the needs.

These figures emphasize the tremendous competition we face for the superior students. With this shortage of graduate "timber," it appears we must guard against two dangers: one is a "down adjustment" of our graduate program to make possible the awarding of degrees to students of less than doctorate caliber; the second is the appointment to our educational staffs of men who are inadequately equipped to lead and direct graduate students in this scientific age. The quality of graduates reflects the quality of

the staff. Our Ph.D. programs must be more rigorous each year if our graduates are qualified to compete equally with the Ph.D. graduates from other science areas.

Education does not stop at the classroom but involves to an even larger extent the adult educational programs of the Extension Service. It is generally recognized that one of the main goals of educational institutions is to develop, to an even greater extent, effective adult educational programs of an in-service nature—programs designed to encourage the employer and the employee to strive constantly for improvement and to keep abreast of rapidly changing times. This is an area of service requiring maximum cooperation of the resident and extension staffs of our institutions.

Another major pathway which justifies attention is the Pathway of Evaluation. This crosses our future and the other pathways previously mentioned. It is the foundation for continued improvement.

In relatively recent years, the term "job analysis" has become much used and meaningful for the commercial industry. This involves a questioning attitude and a careful analysis of each job which is being done to determine if maximum efficiency is resulting—with the minimum of manpower and waste. By no means is this application restricted to the industrial processes but is one that we may utilize ourselves no matter what our particular work may be and no matter what the agency with which we may be associated.

Furthermore, an effective "job analysis" requires first of all an appraisal of the individual —in other words a "self-analysis." Industrial personnel directors have indicated that one of the best approaches to human improvement is that of self-appraisal—provided the individual is honest and will admit his weaknesses and inadequacies.

> When I was a youngster in Kansas, my Uncle Bill visited us at frequent intervals. He was quite an outdoors man—an avid bird hunter—and a braggart in respect to his shooting ability. On one occasion he insisted that I accompany him on a duck hunt so he could demonstrate his marksmanship, and so early one morning we went to Bean Lake which is located a few miles across into Missouri—and nestled ourselves down in a duck blind just as day broke. A flock of ducks came over and one duck settled in the water just a short distance away, in fact, almost within touching distance. My uncle raised the gun and fired—but the duck hardly rustled its feathers and rose from the water and flew majestically away. I looked at my uncle to speak but before I could do so, he said, "Son—you have just seen a miracle. There goes a dead duck flying!"

Here then was a case of failing to face the facts—to admit the truth.

So at this time in the history of our Association and as we look at tomorrow—which is going to be even more demanding than today—it would appear in order that we appraise ourselves, analyze our jobs, and evaluate our Association.

Previous remarks have already indicated various areas where an objective evaluation would be helpful, and it is not desirable to include here suggestions for other evaluation possibilities. Surely, if in our own sphere of activity we approach such an evaluation properly, we can be more certain of rigid standards for college staff members to insure the needed quality for the years ahead, of more effective and meaningful teaching, both at the undergraduate and graduate levels; of greater productivity in research; of more accomplishments in industry programs, and of a highly intelligent and revitalized adult education program in extension.

And our Association also can be immeasurably helped by a complete and critical appraisal of its entire organizational structure and its major activities. The future will require a personal and an Association efficiency not accomplished to date. Perhaps now is the time for us to get our houses in order.

The final pathway I suggest is the Pathway of Enthusiasm.

For one reason or another there seem to be spasmodic outbreaks of pessimism in regard to the future of our industry; to our Association; to our educational program—in fact, to almost any aspect of our entire dairy enterprise. Unfortunately, there have been cases of this pessimism appearing in our educational institutions, and the effect is to create confusion in the minds of the students and to cloud their visions in respect to career opportunities. Such pessimism creates problems between the educational institutions and the commercial industry.

There have been some who have said the days of the independent dairy organization are numbered and that there is no opportunity now for so-called "free enterprise." Such statements can be challenged with supporting evidence! In recent years there have been new dairy businesses developed and smaller independent businesses expanded—some by members of our own Association. These are now strong and progressive organizations. No one company—or type of company—has a monopoly on brains. Stories of these successes can be told our students—if for

no other reason than to illustrate that success is always possible with intelligent and aggressive management.

It does seem that the members of our Association—more than those of any other group in our industry—are the logical ones to maintain a high spirit of morale—and enthusiasm—and positiveness. We are the vulnerable group from the standpoint of training the students and developing future leaders and in advising others on technical and manpower problems. Enthusiasm begets enthusiasm—and we can govern by our actions and words the attitude of both the student and the adult with whom we may work.

In our student relations we can, by our own optimism, convey to the students something of the pioneer spirit—that they will seek opportunity and not security and will go where opportunity exists. Many healthy intangibles of spirit can result through the transfusion of enthusiasm from professor to student.

In terms of our personal relationship to our own industry and our Association, the word "enthusiasm" connotes "loyalty." There is not one of us but who has gotten a great deal from the dairy industry. Most of us have benefited immensely by being a part of this Association. Perhaps the least we can do is to return a little of that which has been given to us. This we can do in the form of loyalty, support, and interest.

So I come to the conclusion of my remarks. These five pathways to tomorrow I have mentioned, the Pathways of Experience, Expansion, Education, Evaluation, and Enthusiasm, are certainly not the only major approaches that need to be considered. There are numerous others as fully worthy of consideration.

I am sure I have said nothing new—and I have talked in generalities. However, the only suggestion I would make in conclusion is illustrated by the story told of Will Rogers:

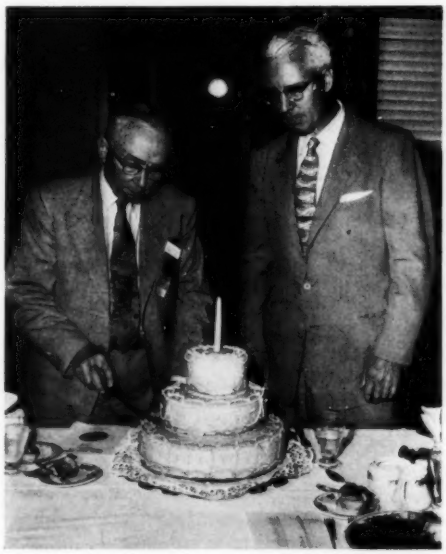
> During the first World War when the submarine menace was so tremendously great and there was much worry about maintaining the sea lanes open to Europe, Will Rogers was talking before a group of young Navy personnel and said, "I can propose a means to you by which you can control the submarine menace. I would suggest you heat all of the water of the Atlantic Ocean to a high temperature—and force the submarines to surface. When they surface, then you can blow them up with the guns of the battleships." Following his presentation, a young Navy officer —bubbling with enthusiasm—came rushing up and said, "Mr. Rogers, Mr. Rogers, that was a wonderful idea, but tell me this. How would you suggest we heat up the water?" Mr. Rogers replied, "Young man! I deal only with principles. It is up to you to work out the details."

KEYNOTE ADDRESS

Dr. A. N. Jorgensen, President of the University of Connecticut, gave an excellent address on the subject "The Challenge to the Land-Grant College." He referred to, and commented favorably on, many of the points covered by Dr. Gould in his address. He indicated that in another ten years, enrollment at the University of Connecticut, as well as at various other Land-Grant colleges, would be likely to double and dwelt on some of the problems in the maintenance of a staff and in providing for the buildings that will be necessary.

PAST PRESIDENTS' DINNER

An innovation this year was a Past Presidents' Dinner, held on Monday evening, June 18. Twelve past presidents and eight members of the Board of Officers were present. Dessert consisted in part of a mammoth Fiftieth Anniversary birthday cake covered with gold frosting. Dr. J. H. Frandsen, now of Amherst,



J. H. Frandsen, founder of the *Journal of Dairy Science*, cuts the 50th Anniversary birthday cake at Past Presidents' Dinner as President I. A. Gould looks on. June 18, 1956.

After the Golden Jubilee Ceremony, President Gould delivered his presidential address on the subject "Pathways to Tomorrow."

Mass., founder and first editor of the *Journal of Dairy Science*, had the honor of blowing out the candles and cutting the cake.

After the dinner, President Gould presided. At a discussion period, the theme of which was "Making Our Association More Effective," various past presidents led the discussion on the following topics:

1. By what means can we improve our communications, within and without?
2. Can we lighten the administrative load?
3. How can we get more participation by individual members?
4. What can we do to expand our relationships with other associations?
5. What should and can we do to increase membership?

The comments proved very much worth while and the consensus of opinion was that this event should be continued again next year.

BUSINESS MEETINGS

June 21, 1956

President Gould introduced some new ideas this year designed to conserve some time for the Executive Board and to make the annual business meeting of greater interest to the membership. The chairman of each committee was asked to prepare detailed and summary reports. These were received by Vice-President Huffman by May 15, and copies of the detailed reports were sent to each member of the Board of Officers. Copies of the summary reports were made and bound together and handed out at the business meeting, known this year as the "Second General Session."

President Gould appointed three subcommittees from the Board of Officers and divided the committee reports between these three committees. The committees were asked to meet on Saturday prior to the first meeting of the Board of Officers in order to review their reports and come before the Board with recommendations. The whole plan worked remarkably well. Vice-President Huffman received all of the reports on time; the reports were probably more complete than previously; they saved time for the Board of Officers and permitted them to act in an orderly manner; and the plan certainly helped greatly in the success of the Second General Session.

The Board of Officers met all day Sunday and Monday, June 17 and 18, and also for a portion of the afternoons of Tuesday and Wednesday, June 19 and 20.

The Second General Session—the business meeting of the Association—was convened by President Gould at 10 A.M., June 21. There were approximately 500 members present, and interest remained good throughout the two-hour meeting. Following comments by the President concerning the growth of the Association and the circulation of the Journal, Secretary-Treasurer H. F. Judkins was called upon to present the actions of the Board of Officers for the approval of the membership, which he did as per the following condensation:

1. Interim mail actions of the Board.
   a. Affiliate Branch charters granted on a continuous basis provided the Dairy Club remains active, instead of granting new charters every three years, as has been the practice.
   b. Approved the establishment of a statewide division of A.D.S.A. in Louisiana.
   c. Confirmed invitations for annual meetings as follows:
      1959—University of Illinois
      1962—University of Georgia
      1963—Purdue University
      1965—University of Kentucky
      Note—At one of the Board of Officers sessions an invitation from the University of Maryland was accepted for the year 1964 and an invitation from Texas A & M should a vacancy occur prior to 1965.
      Schedule of annual meetings now stands as follows:
      1957—Oklahoma A & M
      1958—North Carolina State
      1959—University of Illinois
      1960—Utah Agricultural College
      1961—University of Wisconsin
      1962—University of Georgia
      1963—Purdue University
      1964—University of Maryland
      1965—University of Kentucky
      1966—Oregon State College
   d. Accepted support from National Dairy Products Corporation for Teaching Award in Dairy Production.
   e. Awarded Special Charter Memberships to Charles Thom, Carl Lee, and C. F. Doane; elected to Life Membership B. W. Hammer, L. A. Maynard, A. J. Cramer.
   f. Voted to honor the Historian and award Honorary Membership.
   g. Appointed Special Committees on Education, A.D.S.A. Division Coordinating, and Personnel Training Manual preparation.
   h. Approved publication of Special Golden Anniversary June issue of the Journal.

i. Voted to operate a booth at the Dairy Industries Exposition in Atlantic City this fall.

The membership approved the Constitution and By-Laws appearing in the October, 1955, issue of the Journal by a vote of 445 to 6.

2. Actions at Board meetings held during Annual Meeting:
   a. Appointed J. B. Frye of Louisiana State University as representative of Purina Fellowship program for three years.
   b. Elected D. H. Jacobsen, American Dairy Association, as a member of the Journal Management Committee.
   c. Elected N. P. Ralston, Michigan State University, as Chairman of the Program Committee for 1957.
   d. Approved appointment of committee to study possibility of A.D.S.A. representation with the World Dairy Congress Federation.
   e. Requested incoming president to give consideration to appointing a liaison committee of three to confer with U.S.P.H.S. on subject of research in the public health field.
   f. Accepted with appreciation and thanks awards offers for 1957 from Milk Industry Foundation, teaching in dairy manufactures: from the De Laval Corporation, the Extension Dairyman's Award; from the Borden Company, awards for research in dairy manufactures and dairy production; from the American Feed Manufacturers, award for research in dairy cattle nutrition, for three-year period.
   g. Placed on file for future consideration at the Annual Meeting, invitation from Virginia Polytechnic Institute for the year 1972.
3. Suggested that the Secretary include in the Procedural Handbook procedure information for use of Host Institutions in arranging for annual meetings and voted that the Secretary, at the request of the Host Institution, visit said institution to assist with laying plans for annual meetings.
4. Because of Editor Tracy's desire to relinquish his responsibilities at the end of 1956, a special committee was appointed to make arrangements for the handling of the Journal.
5. Re-elected H. F. Judkins as Secretary-Treasurer.
6. Approved a 50th anniversary statement of objectives of the A.D.S.A. to be published in the Journal and released to the dairy press in general.
7. Approved request of the Student Affiliate Committee that winners of outstanding club activity exhibits at this year's meeting be granted suitable certificates of merit. This year's winners were as follows: Student Branch of the A.D.S.A., Ohio State University; Virginia Tech Chapter of the A.D.S.A., Virginia Polytechnic Institute; Minnesota Dairy Science Club, University of Minnesota; Dairy Science Association, Rutgers University; The Dairy Science Club, Louisiana State University.
8. Gave authority to the President and Secretary to aprove all applications for affiliate charters from various dairy clubs during the coming year.
9. Passed a motion commending and congratulating President Gould for the outstanding manner in which he has conducted the affairs of his office.
10. Committee Reports. Note: The Secretary arranged Board action on the Committee reports exactly as per the arrangement of the summary committee reports in the hands of the audience and as he gave the following Board action, members of the audience could follow him by quickly noting the report summaries in their hands and which they were privileged to take away with them. The plan seemed to work very well.
    A. Accepted the report of the Ballot Tabulating Committee. Candidates for vice-president were D. V. Josephson and E. L. Jack. D. V. Josephson elected.
    For director: Candidates were R. Whitaker and E. H. Parfitt. E. H. Parfitt elected.
    For second director: Candidates were G. Werner and Ray Albrechtson. G. Werner elected.
    B. Accepted Secretary-Treasurer's report:
    Total income for the calendar year 1955 was $62,724.45 as against $47,-019.17 for 1954. Expenses calendar year 1955 amounted to $51,486.05 as against $46,162.81 in 1954. Major changes in income were: memberships up $1000; subscriptions up $4500; advertising up $3500; reprints from nothing in 1954 to $7500 in 1955. Major items of expense increase in 1955 as compared to 1954 were: cost of Journal; cost of secretarial supplies; and various miscellaneous items principally due to Golden Jubilee Year activities.
    Based on this year's operations to June 1, it would appear that 1956 in-

come should be close to $70,000 and that we should break a little better than even for the year. It appears likely that both income and expenses may be somewhat higher in 1956 than 1957 due in part to the extra advertising received in connection with the June issue and to the extra cost of the June issue. The budget approved by the Board of Officers for the calendar year 1957 was $65,200.

As of May 1, 1956, memberships stood at 2,010; affiliate membership, 493; and subscribers, 1,491. Considering the increases that have taken place since May 1, it appears that for 1956 we shall have at least 300 more members, 125 affiliate members, and 100 more subscriptions than we had in 1955. The number of student affiliate chapters increased from 27 in 1955 to 35 in 1956.

A breakdown of our membership classification has already been printed in the Journal. Briefly, it shows that 42% are engaged in teaching, research, or extension as against 38% engaged in commercial dairy plants or the manufacture and sale of dairy equipment and supplies. The balance are scattered among 18 other classifications. Affiliate members are 54% in the graduate and 46% in the undergraduate classification. Of our subscriptions 57% are from foreign countries, and 69 countries are represented. There are approximately 90 subscriptions each in England and Japan and 44 in Russia. All 1955 members rejoined the Association in 1956 except 111. Of these 46 had been members for only one year and 19 for two years. Thirty-four had been members well over five years. While there is nothing for comparison for the previous year, this would seem to be quite a good record.

C. Accepted Editor's report:

Volume 38 of the Journal contained 127 original articles, 5 reviews, 18 technical notes, and 23 "Our Industry Today" articles. This represents a decrease of 24 original articles, an increase of 3 reviews, an increase of 15 technical notes, and a decrease of 4 "Our Industry Today" articles, as compared with the previous volume. The 1955 volume contained 1,434 pages as compared with 1,510 pages for the previous year, plus 161 pages of abstracts as compared with 191 pages for 1954. The total pages of "People and Events" for 1955 was 66 as compared with 62 for the previous year.

In 1955 there were 111 production articles and 65 manufacturing articles submitted for publication—a ratio of 63 to 37. The percentage of rejections was approximately 16 for production and 9 for manufacturing. The total rejection was 25 articles, or 14%.

A new department for student affiliates, edited by Professor E. L. Thomas of Minnesota, was launched in the 1955 volume.

Several new advertising accounts have been obtained since the last meeting. Through the combined efforts of all the Association officers the June issue carries the largest amount of advertising ever appearing in any one issue of the Journal. Members are urged to read these advertisements carefully. The officers of the Association would appreciate having the members write to at least the advertisers known to them to express appreciation for their support of the Journal.

The "People and Events" section could be greatly improved if more department heads would lend their support. Some departments are never heard from and some only occasionally. Part of the news is too old to use by the time it reaches the editor. News should not be limited to university happenings but should include important events in industry.

The editor wishes to express his appreciation to all those who have given so generously of their time in order to contribute to the success of the Journal. The officers and directors have all been most helpful. The Journal Management Committee have all aided in the progress of the affairs of the Journal. The staff of The Garrard Press have cooperated with the editor in a splendid manner. To Mrs. Rosamond Tracy much credit is due for her assistance in editing the Journal articles. Acknowledgment is also made of the help of W. O. Nelson and those who assisted him in abstracting, and E. L. Thomas, the editor of the section for student affiliates.

To those who have served on the Editorial Board much credit is due. They contribute much time in reviewing articles in their respective fields to make sure that submitted material meets the standards that have been set for the Journal. The editor expresses to these

men his thanks for the splendid job they are doing. Credit is due also to the persons not listed on the Editorial Board who have been called upon for assistance in the review of papers.

The editor urges the members to write him regarding suggestions for improving the Journal. He would like opinions regarding changes that have been made. It has been suggested that the size of the format be increased so as to make the Journal more attractive to advertisers. A change in color of the cover page also is being considered. It is your Journal so you should help set the policies affecting it. — P. H. Tracy, *Editor*.

D. Received report of Journal Management Committee.

The Journal Management Committee has worked closely with Editor Tracy and executive officers of the Association pertaining to a wide range of Journal affairs. Our primary goal this Jubilee year has been to lend every possible means of assistance to the Editor in developing our Journal so it merits greater usefulness to our membership and wider reader acceptance. We have also kept before us the aim for developing increased income through advertising and sale of reprints and subscriptions.

Action taken by the Journal Management Committee during the past year included the following:

1—Upon recommendation of the Editor, approved the following appointments to the Editorial Board, effective January 1, 1956:
N. L. VanDemark, Illinois, to review articles in physiology and endocrinology.
Stuart Patton, Pennsylvania, to review articles in chemistry.
R. W. Bratton, New York, to review articles in artificial insemination.

2—Decided to extend gratis memberships to the members of the editorial board during their term of office.

3—After careful study, the committee recommended that the membership list of Association members not be published in 1956. The demand for such a list appears not to justify the cost of approximately $400 which is involved.

4—The committee decided the Secretary should execute arrangements for copyrighting each issue of the Journal. This will involve a cost of $4.00 per month, which should be offset by additional sale of reprints, since it has been known that a number of articles have been reproduced without the permission of our Association. (This has been done.)

5—List of complimentary subscriptions was carefully studied with the Editor and Secretary, and a number of these subscriptions dropped from the list. Complimentary subscriptions now number approximately 30, and and are issued merely to advertisers and advertising agencies.

6—It was recommended that the Association not enter into Journal exchange agreements with organizations in other countries.

7—The committee approved granting a 10 per cent discount to organizations purchasing five or more memberships in one subscription order. Also, approved giving a 10 per cent discount on single five-year subscription orders.

8—Recommended price of complete back volumes be $10.00 per volume.

9—Approved special advertising rates for six insertions per year.

10—Approved the exchange of advertising with Dairy Science Abstracts of England.

11—Approved the use of unprinted envelopes for mailing copies of the Journal sent to foreign countries. Wrappers which have been used heretofore have resulted in series of complaints on torn and lost copies. The use of these envelopes involves an additional cost of $1.90 per 100 issues, and this expenditure seems wise in connection with our foreign subscribers.

12—Recommended publication of a special Anniversary issue of the Journal to be published as the June issue, and recommended the cost of this issue to be held to $8,000.

13—Recommended that a condensation of the very complete history of the Association, which has been prepared by Doctor G. Malcolm Trout, be published in the June issue.

14—The committee kept in close communication with Editor Tracy regarding further changes made in the Journal arrangement of advertising and news items. Approval was given to interspersing advertising through some of the popular sections, and the commit-

tee has attempted to determine the reaction of our readers. The committee also suggested the Editor include a brief summary in heavy type at the beginning of each scientific paper.

15—The committee has received with real regret the resignation of Editor Tracy and his associate, Mrs. Tracy, effective with the December issue of this year.

The Journal Management Committee makes the following recommendations to the Executive Board for action:

1—Upon recommendation of the Secretary-Treasurer, it seems wise to have the publisher, The Garrard Press, take care of all matters pertaining to handling of subscriptions. This would relieve the Secretary-Treasurer of a phase of work which has been increasingly burdensome to his office. In addition to relieving the Secretary, it makes possible for these matters to be handled promptly and reduces the chance of error. This would not involve any changed procedure in the handling of memberships and affiliate memberships.

2—The committee has further explored the desirability of changing the format and page size of the Journal. We find a larger size would have a number of advantages, including slightly lower printing costs, better advertising display, and more modern style. Larger size format is more commonly used today; therefore, standard advertising plates can be used. The committee recognizes there are, likewise, disadvantages to a change in size. Among the disadvantages—some people prefer a smaller size Journal when reading; those who bind issues will object to the change in size; and some people just resist any kind of change.

The committee wishes some expression from the Executive Board as to whether it would favor a change in format beginning with the January, 1957, issue or whether the Board favors the status quo.

3—Since Editor Tracy has indicated his desire to relinquish his duties upon completion of the December issue, arrangements should be made for a successor to Doctor Tracy. The committee has observed that the work of editing our Journal is demanding more and more time. We do not believe a single person will be prevailed upon to undertake the editorship under the conditions we have heretofore operated. There are several alternative procedures, and the committee believes it should first have an indication from the Board as to the direction of organizational arrangement it desires to pursue.

The Journal Management Committee desires to point out to the membership the very great progress our Journal has made under the leadership of Editor Tracy and the editorial staff. Our Association is greatly indebted to Editor Tracy, Mrs. Tracy, and the Editorial Board for their excellent work and guidance in developing our Journal. It is outstanding today among scientific journals, exhibiting high quality in technical editing and readability. Editor Tracy's vision, resourcefulness, and skillful handling of editorial responsibility have been major factors in elevating our Journal to the position it now occupies.

The members of the committee appreciate the necessity which makes it seem advisable for him to resign from the position of Editor. We regret exceedingly the loss the Association must sustain. We wish him the joys and feeling of satisfaction which result from a job well done.

Respectfully submitted,

W. M. Roberts
George M. Werner
J. Hoffman Erb, *Chairman*

E. Accepted the report of the Auditing Committee.

F. Accepted the report of the Historian with special commendations for a tremendous job in connection with the Jubilee history. Voted to ask the Historian to cooperate with the Secretary in bringing about a tabulation and indexing of Board actions over the years.

G. Accepted the report of Membership Committee. The recommendations follow:

1. That the general plan be followed as in 1956 of dividing the U. S. into eight sections (or thereabouts), and Canada in addition, with carefully chosen energetic sectional chairmen of experience to supervise the respective areas.

2. That a national chairman be appointed who: *(a)* believes in the Association and its future, *(b)* has organizational ability, and *(c)* has the background experience to lead with vigor and judgment the membership drive for the coming year.
3. That the drive for 1957 be organized at an early date (at least early fall) with the sectional leaders selecting outstanding representatives of the Association to act as chairmen and cochairmen on a state basis.
4. That state chairmen be encouraged to appoint a representative from each agricultural college or university, setting a goal of 100% membership therein, and to collect the membership dues within the department between Nov. 1 and Nov. 15 and send to the Secretary of the Association.
5. That memberships be sold on the basis of training and interest and in full accordance with the by-laws of the Association.
6. That each state chairman be supplied with a list of the general dairy organizations from which memberships might be obtained.
7. That emphasis be placed on more subscriptions, making the Journal more accessible to people in libraries, companies, and organizations.
8. That a much greater effort be made in foreign contacts not only to enlarge foreign memberships but in bringing about more friendly relationships with the American Dairy Science Association.
9. That the Board of Directors study the question of memberships for commercial companies and concerns where several employees have ready access to the Journal, made available either by a single subscription or a membership of only one member. (Question): How can the several employees be made sufficiently interested to accept membership?
10. That worthy lifetime memberships be recognized by the Board of Directors in more increasing numbers if and when applications are received by the Board.
11. That the Student Affiliate Committee be continued under energetic and wise supervision.

That the dignity of the dairy industry and the standards of the American Dairy Science Association be upheld in the sale of memberships—that the quality of individual members and the good the Association can bring to them be emphasized, not mere volume in memberships.

H. Report of the Program Committee received with commendations for a job well done.

I. Received the report of the Public Relations Committee and referred it back to a new committee for development of new proposals for consideration of the Board. Commended the committee for the broad scope of its activities. Recommended that the incoming President continue the committee with a core of men who have already served.

J. Report of Student Affiliate Committee received with commendation to Dr. Slatter for a good job. The committee is requested to develop the program for recognizing outstanding undergraduate students. Recommendation that committee be increased to six members with three-year terms, two to be replaced each year, was approved.

K. Received report of Committee on Antibiotics and voted that the Association urge the continuation of educational work and studies on methods of testing for antibiotics and that we should avoid resolutions leading to actions by regulatory agencies. Voted that the matter of continuing the committee be left to the incoming President.

L. Accepted the Awards Procedures Review Committee report with commendation for work well done. Minor suggestions and modifications referred back to Dr. Garrett, Chairman of the Committee, to be incorporated in the procedures and referred to the President and Secretary. No further Board action necessary.

M. Accepted report of the Education Committee with the request that it be called to the attention of the Program Committee. The Committee's three recommendations are as follows:

1. It is apparent that there is need for, and interest in, wider discussion of education subjects at the annual meetings. Formal encouragement should be given to the inclusion of such material in the programs.
2. The existing framework of the Association seems adequate at the present time for the inclusion of education

subjects and a separate section should not be established unless and until an apparent need for it is developed.

3. A continuing Committee on Education should be established with broad responsibilities to insure proper attention to matters in this field.

N. Voted to receive report of the Advertising Survey but make no commitments at this time. Matter to be considered by the Special Committee appointed to investigate editorial arrangements.

O. Voted that the report of the Committee on Personnel Manual Preparation be received and that a committee be continued to bring into being this manual.

P. Report of Association-Division Coordination Committee received. Board recommended that each Division invite a representative of the Association to present at their annual meetings problems of the parent association. Voted that the committee be continued with the Secretary-Treasurer as an ex-officio member. Voted that the $25 per year support, for the time being, at least, be limited to the Eastern, Southern, and Western Divisions.

Q. Accepted the report of American Association for Advancement of Science Representative with thanks to Dr. Wise for a very fine representation.

R. Received the report of the Inter-Society Cooperation Representative and voted to allocate $100 per year in support of this program.

S. Accepted the report of the Dairy Remembrance Fund. The three graduate student assistant grants in the amount of $500 each have been voted for the coming fiscal year. Five hundred dollars has been allocated to the National Dairy Council to be used for the establishment of a Dairy Reference Library.

T. Accepted the report of the Dairy-Wide Coordination Committee on Nutrition Research.

U. Accepted the report of the Joint Committee on Grassland Farming. The committee notes that the Joint Committee on Grassland Farming has arranged for a symposium on "Grasslands in our National Life" at the annual meeting of Section O, Agricultural, of the American Association for the Advancement of Science, this winter.

V. Report of the National Research Council Representative was received with instructions that it be published in the Journal. Voted that the Association contribute $100 to the cost of distribution of the Recruitment Manual prepared by the National Academy of Science.

W. Report of the Committee on Ralston Purina Fellowships. This report on the actions of the Board of Officers was unanimously accepted.

X. The report of the Necrology Committee, presented by G. C. Graf, was accepted. The audience stood in a moment of silence out of respect to the following who were members at the time of their decease: J. A. Anderson, Missouri; W. N. Angle, Virginia; R. S. Breed, New York; L. M. Dorsey, Maine; H. D. Drain, Ohio; W. J. Hardy, Missouri; Gerald Heebink, West Virginia; L. A. Higgins, Mississippi; G. E. Holm, Washington, D. C.; H. G. Lindquist, Massachusetts; J. C. Marquardt, New York; F. W. Milner, California; C. F. Munroe, Ohio; L. F. Nafis, Illinois; R. T. Stahl, Wisconsin; Charles Thom, New York.

Y. J. L. Hileman, Chairman of the Resolutions Committee, presented resolutions covering the following:

1. Commending the Milk Industry Foundation for its sponsorship of a survey and study of the problem of training personnel for the dairy industry.
2. Commending the Dairy Industry Committee for appointing the Subcommittee on Education and Training and also commending this Subcommittee for the progress it has made toward the preparation of materials for use in encouraging young men to study dairy manufacturing.
3. Commending the Dairy Industry Committee, the United States Public Health Service, and the International Association of Milk and Food Sanitarians for the work that they have done through the Sanitary Standards Committee toward standardizing and improving the sanitary design of equipment for the dairy and food industries.
4. Recognizing the 50th anniversary of the enactment of the Federal Food, Drug, and Cosmetic Act and commending the Food, Drug, and Cosmetic Administration for its fine work with particular reference to its role in the improvement of dairy products.

5. Expressing appreciation to the many commercial organizations that have contributed to the success of this 50th Anniversary meeting of The American Dairy Science Association.
6. Thanking the Borden Company for its presentation of the Borden Awards in dairy production and dairy manufacturing.
7. Thanking the American Feed Manufacturers Association for supplying the award for outstanding research in dairy cattle nutrition.
8. Thanking the DeLaval Separator company for making available the DeLaval Extension Dairyman Award for outstanding achievement in dairy extension.
9. Thanking the National Dairy Products Corporation for making available the Dairy Production Teaching Award.
10. Commending the American Dairy Association and the National Dairy Council for their efforts in promoting the consumption of milk and milk products and for providing funds to support research in various fields of dairy science.
11. Thanking the University of Connecticut and all of the staff for their work in planning and carrying out the many details which have made this 50th Anniversary meeting an outstanding success.
12. Recommending that Congress appropriate funds for a modern and adequate Animal Disease Research Laboratory.
13. Thanking local associations and companies for their support by carrying advertising in the *Journal of Dairy Science* through the year and especially the Golden Jubilee Anniversary number.
14. Commending the several Pure-Bred Cattle Associations and the National Association of Artificial Breeders for their work in improving dairy cattle.
15. Commending and thanking the Dairy Industry Supply Association for supporting the Student Dairy Products Judging Contests and for giving scholarships to the winners of the contests.
16. Thanking and commending Dr. Paul Tracy for his work as Editor of the *Journal of Dairy Science*.

Report of the Resolutions Committee accepted.

The items of business having been disposed of, President Gould reported on some of the major objectives of the Association which he listed in the September, 1955, issue of this Journal. A goal of 2,000 members had been set. This has more than been reached and membership is now about 2,100.

Affiliate membership has received more attention by the Chairman of the Student Affiliate Committee, Dr. Slatter of Ohio, and the Secretary-Treasurer. The result is now about 535 affiliate members as against 408 last year and an increase in the number of student branches from 27 to 35. Dr. Gould pointed out that the advantages of affiliate membership offset any possible arguments against it which are held by some and stated: "If students do not understand the Journal—can't get some ideas—then something is wrong with our educational program."

The next item covered the development of greater inter-association cooperation. It was stated that while some progress had been made during 1956 there was still room for much improvement. Activity with the Dairy Industry Committee has been largely through an Education subcommittee, of which J. Hoffman Erb of our Association is chairman. The Association hopes to work with this subcommittee in the promotion of printed recruitment material as well as a public relations file. While members of our Association are members of the 3A Sanitary Standards Committee, it is desirable that our Association be officially represented on this committtee. We should also be cooperating with the U. S. Public Health Service and the Executive Board has approved the establishment of a committee to explore fields of research of interest to U. S. Public Health Service and Association members. Other organizations with which the Association should have closer contact are the American Dairy Association, the National Dairy Council, Dairy Trade Associations, and the American Public Health Association.

Dr. Gould suggested a project for promoting the part that dairy science is playing in our industry and suggested a "Dairy Science Progress Week."

The improved financial situation of the Association received favorable comment but it was pointed out that still more money was going to be needed in the operation of the Association—more money for the editor and his staff—more money for the Secretary-Treasurer—additional money for assisting the President with his administrative responsibilities—and more monies

to make possible additional meetings of important committees and of the Executive Board at other than the annual meeting.

President Gould pointed out the heavy administrative load carried by the officers of the Association and stated that nearly half of his time during the past year had been devoted to Association affairs. Improvement in this respect has been made during the past year by streamlining the handling of reports and by the revision of the award procedure as developed by Dr. O. F. Garrett and his committee. Dr. Gould suggested that Association committees be kept to a minimum leaving the subject matter of committees to the Sections.

President Gould stated that keeping the interest among the members of the Association at a high level was very important and stated that one of the means of bringing this about was to distribute the work load as much as possible and to keep the membership advised as to various Association activities. An attempt has been made to do this during the past year through:

1. Editorials and reports to the members through the Journal.
2. Personal letters of welcome to all new members and affiliate members in the Association.
3. Various sections of the Journal of general interest.
4. Public Relations Committee publicity.
5. Developing greater coordination between the Divisions and the Parent Organization. Have invitation of representative of Parent Organization to attend.
   a. Establishment of Louisiana Division.
   b. Encourage greater participation in Division—articles and reprints in the Journal.
6. Changing style of so-called business meeting. Many of you have expressed a desire for a change—to eliminate the multitude of formalized reports. We have attempted to make the reports available to members for their perusal so that they may ask whatever questions wished in respect to any of them. The whole purpose of this meeting is to attempt to create a situation so that there will be a free exchange of information relative to our Association and all matters of mutual concern to its members and officers.

Finally, President Gould showed some charts covering the Journal—its circulation—type of articles and distribution of articles as between production and manufacturing. The importance of more articles on the manufacturing side was stressed, especially since nearly 40% of our membership is engaged in that area of business.

President Gould then opened the meeting for discussion by introducing discussion leaders on various topics: R. E. Erb, Chairman of the Program Committee for the 1956 meeting, presented the following comments:

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President Gould, members of the American Dairy Science Association, and friends of our Association: Were you ever asked to pick up a 500-lb. square piece of opaque glass without the benefit of handles? If so, you can appreciate my present predicament. The subject, "What About Our Annual Meeting?" in five minutes or less is realistically a challenge.

Certain questions relative to the assigned subject have been advertised for discussion. They are as follows:

(a) Can we continue to meet at educational institutions?
(b) Do we need a longer meeting?
(c) Can the number of papers be reduced?
(d) Can we improve the quality of the program?

All of the credit for any new ideas, particularly the good ones, can be given to those most intimately concerned with our 50th Anniversary program. The suggestions sent to me by Gould, Ralston, Roberts, Werner, Moore, Tracy, and Judkins were greatly appreciated. The first question, "Can we continue to meet at educational institutions?" can definitely be answered Yes. We have at the present time invitations through 1966. The greatest number ever to attend an annual meeting was 1,632 in 1953 at the University of Wisconsin. Facilities of the host institutions are generally increasing and should easily stay ahead of our own expected growth.

The second question, "Do we need a longer meeting?" enjoys negative unanimity among my correspondents. We now use the better part of four days with three days of formal meetings and one day to get set. For those traveling any distance a full week is required now. Opportunity for visiting places of special interest should not be overlooked. Further, our annual meeting should be a stimulating and pleasant experience and not a marathon to see which end of our anatomy can be subdued first.

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nual meeting in Pennsylvania there were 50 production papers compared with 97 papers in 1954 when our meeting was again at Pennsylvania State University. In 1953 and 1955, 109 papers were presented before the production section compared with 73 and 66, respectively, for the Manufacturing and Extension Sections combined. The Extension Section had 17 papers in 1935 and 1936 compared with an average of 10 for the past four years. The Manufacturing Section has not shown consistent increase since 1948. Therefore, I assume the voluminous criticism of too many papers is aimed at the Production Section.

Some historical facts are appropriate. Twenty years ago we had 850 members who presented 98 papers, which represented 11.5% of the membership. This year, papers presented represent 7.4% of the membership. Only one year, 1953, was equal to the 1936 percentage participation.

Inseparably tied up with the number of papers is the type of program that is best. We wish to attract and interest all members of our Association. To do this is impossible unless we are agreed that a large number of sections conducted simultaneously is the proper thing to have. Consider the wide interests of our membership. Our industry members (33% of our total membership) and our extension personnel demand and should receive the best we can offer in special topics. The group concerned primarily with teaching wish an opportunity to discuss better instruction and improved curricula. Our administrative segment is asking for a place on the program to discuss administrative departmental problems. The research man is becoming more and more specialized and is most content when attending programs offering a series of highly technical papers in his specialty. My candid opinion is that the specialized research man will not attend a program that is too general nor will our members with broad general interests attend meetings that are too technical. We must have both groups. Therefore, the answer is relatively obvious to me. The current trend is in the right direction, i.e., a balance between basic, applied, and interpretative research. Therefore, a program offering several types of specialized presentations simultaneously is commendable.

There is a considerable segment of our Association who feel:

1. There should be fewer technical papers.
2. There should be more papers by senior members.
3. There should be more summarization talks.
4. There should be more time for discussion.

Any method devised to limit papers even to the extent of reading by title is undemocratic and unsatisfactory. The Production Section is now limiting authors to two papers and has asked department chairmen to carefully scrutinize the offerings from their departments. The suggestion has been made that section committees select only the best papers. Strangely enough, this kind of suggestion is not made by men after they have had the experience of working on a section program.

Our best efforts perhaps can be achieved by working on program quality. Several of my colleagues have made the following excellent suggestions:

1. Limit papers to finished project reports.
2. Accept only descriptive titles which are accompanied by abstracts showing essential statistics on what has been done and what has been observed.
3. Invite outside speakers who are distinguished in their respective scientific fields.
4. Build programs to meet the needs of different interests in our Association.
5. Continue to encourage our senior members to submit papers.
6. Practice giving papers before presentation so that good organization and clearness of thought can be achieved.
7. Provide ditto or mimeographed handouts in lieu of slides, using slides only when photographs are involved.

In all fairness, I believe we can all agree that program quality has improved. However, we cannot rest on past accomplishments. Basically our Association rests on scientific accomplishments. I sincerely believe this is, and must continue to be, the nucleus of our Association and that this best serves our purpose of (1) seeking facts, and (2) disseminating the facts in various ways to the maximum benefit of all our readers. How else can we maintain our goals of technical and educational leadership to our industry?

Following Mr. Erb's presentation, some of the comments from the floor were as follows:

1. The Program Committee to require the complete paper as well as the abstract in advance of the meeting.
2. The speaker would do well not to read a paper at the meeting but rather elaborate on the abstract which appears in the program in the hands of the audience.
3. Speaker should take less time in describing techniques used, in the work presented.

MEMBERSHIP

Lyman H. Rich, Chairman of the Membership Committee, presented the following excellent comments concerning membership:

What does membership in the American Dairy Science Association mean to you? Is it membership, is it finance, is it the Association's respective divisions to which you belong, is it largely research, teaching, or the extension of programs to the farms and the homes?

Could it be the combination of all these which represents the greatest single agricultural organization in existence today, so far as health, income, family living, and future possibilities are concerned?

No matter how you look at it, if you are one of the 2,000 members, this Jubilee Year, you have a reason. So far as I am concerned, membership in the Association is the privilege of the chosen few. It means the constant living day by day, month by month, and year by year, the faith of its founders, the needs of modern industry, the will and the courage to uncover the unknown, and make those discoveries and investigations more useful to man. I'm sure that I bow very humbly before that last statement.

The size of the Association may not be the important thing. Individual membership is important. We must believe in the future of the American Dairy Science Association if it means much to us. How could we waver after hearing the recent masterful addresses of your president and the president of this honored institution?

The strength of the Association probably lies in the resourcefulness of the individual. Of one thing I feel we are all rather certain. We don't want to sell ourselves downhill in memberships. With full dignity, however, we may not have scratched the surface of those who need the blessings of the Association. What are your ideas? Would 2,000 Committees of One, in the next year, be helpful in enlisting membership; in paying of dues promptly; in lending a willing hand on a committee, and keeping the standards of the Association at a high level? Your answers I'm sure will be better than mine.

Dairy organizations today are enlisting better qualified personnel the country over. A few stalwarts are motivating the younger generation into real action. What is your answer as to membership? Where would you draw the line?

It was commented from the floor that once or twice a year, a brief summary of important articles with reasons for becoming a member or subscriber might be sent to the membership.

B. M. Zakariasen, Chairman of the Public Relations Committee, discussed ways and means of making the influence of the Association's activities of greater interest and value to industry, as well as ways in which the industry could help the Association. The report of the Committee to the Board of Officers was discussed in some detail.

J. Hoffman Erb, Chairman of the Journal Management Committee, discussed the Committee report appearing elsewhere in this Journal, covering particularly the questions: How can we increase the effectiveness of the Journal? Can we maintain a balance of articles? How can we finance its improvement? Perry Ellsworth commented that he felt the interest of the Journal for many of its readers could be enhanced by prefacing the scientific articles with a brief statement which would cover the purpose of the work and how it fitted into a possible larger general problem. He felt that the statement could also cover a brief summary of the article.

E. L. Jack, Chairman of the Education Committee, discussed "Our Role in Education." He reported that the symposium had proved to be successful and of great interest. He further discussed such questions as *(a)* industry's treatment of college-trained men; *(b)* secondary-school counseling; *(c)* improving teaching methods and practices; and *(d)* the use of the Journal as an undergraduate teaching tool.

It was reported that registration at the meeting totalled 1,415.

REPORT OF REGISTRATION COMMITTEE

State	*Men*	*Women*	*Children*	*Total*
Alabama	1	—	—	1
Arizona	2	—	—	2
Arkansas	—	—	—	—
California	16	3	1	20
Colorado	3	—	—	3
Connecticut	64	30	28	122
Delaware	5	4	2	11
Florida	4	1	1	6
Georgia	4	3	5	12
Idaho	—	—	—	—
Illinois	80	38	38	156
Indiana	18	1	3	22
Iowa	15	5	7	27
Kansas	6	3	3	12
Kentucky	13	1	2	16
Louisiana	5	2	3	10
Maine	7	1	2	10
Maryland	37	12	11	60
Massachusetts	36	9	6	51

Michigan	34	18	9	61
Minnesota	21	11	5	37
Mississippi	—	—	—	—
Missouri	16	7	3	26
Montana	3	—	—	3
Nebraska	11	6	3	20
Nevada	—	—	—	—
New Hampshire	13	1	—	14
New Jersey	32	8	10	50
New Mexico	—	—	—	—
New York	115	36	10	161
North Carolina	24	6	8	38
North Dakota	2	1	1	4
Ohio	55	28	19	102
Oklahoma	6	2	—	8
Oregon	1	2	2	5
Pennsylvania	48	20	9	77
Rhode Island	6	1	—	7
South Carolina	3	1	—	4
South Dakota	2	—	2	4
Tennessee	7	—	—	7
Texas	7	1	3	11
Utah	4	5	2	11
Vermont	13	5	1	19
Virginia	17	12	6	35
Washington	3	—	—	3
West Virginia	4	1	—	5
Wisconsin	46	14	8	68
Wyoming	1	1	—	2
District of Columbia	26	7	4	37
Totals	836	307	217	1,360

Territory or Country	*Men*	*Women*	*Children*	*Total*
Alaska	1	—	—	1
Australia	2	1	3	6
Canada	25	9	6	40
Chile	1	—	—	1
Finland	1	—	—	1
Israel	1	—	—	1
Jamaica, B.W.I.	1	—	—	1
New Zealand	1	—	—	1
Union of South Africa	1	—	—	1
Uruguay	1	1	—	2
Total	35	11	9	55
Grand total	871	318	226	1,415

REPORT OF THE EXTENSION SECTION

The opening business session was called to order by Chairman G. M. Werner at 1:30 P.M., June 19.

Officers elected for next year were: *Chairman*, J. D. Burke; *Vice-Chairman*, L. R. Fryman; and *Secretary*, L. A. Johnson.

The following committees reported:

1. Dairy Records: The report included recommendations on revision of Nurse-Cow Rule, identification numbers acceptable for use in sire-proving program, change in rule 6, and centering day survey. The report was approved after an amendment to leave rule 6 the same as it now appears in the DHIA Manual.
2. Teaching Methods: There were exhibits of teaching aids and demonstrations from 14 states.
3. 4-H Club: The report consisted of the presentation of a paper on "4-H Dairy Calf Placement Programs" and a panel discussion on "A Look at Our Junior Dairy Show Program." A committee consisting of C. W. Nibler, R. G. Fincham, and W. N. Patterson was appointed to recommend terms to designate the 1-2-3 system of judging, the so-called "Danish System," and the combination of the two systems for universal use.
4. Breeds Relations: The committee recommended slight revisions in the Uniform Testing Rules, continued effort to have all forms of dairy records computed on a centering day system, and that breed associations make a concerted effort to keep exceptions to Uniform Testing Rules to a minimum. Approved.
5. Breeding: The following recommendations were made:
   a. Plans to develop a uniform program that will provide adequate control of deleterious recessives in artificial breeding.
   b. Increase use of high-speed tabulating equipment for the processing of DHIA and HIR records on a monthly basis.
   c. Further study on Extension of short records to 305-day for sire-proving. Approved.
6. Type: The report covered the following:
   a. Review of published research on type conformation.
   b. Present status of type as a part of dairy cattle breeding programs.
   c. What we need to know about type. Approved.
7. Health: The slogan of the Dairy Cattle Health Committee is "Implementation Through Education." The report consisted of a discussion of ways to promote educational work through (a) cooperation with other livestock health agencies, and (b) the sponsorship of active projects within the American Dairy Science Association. Approved.

New Business

At the Tuesday afternoon session, Dr. J. F. Kendrick introduced the Weigh-a-Day-a-Month Program for consideration. He reported on the work done by a committee consisting of Senger, Cash, Voelker, Crowley, and Albrectsen. This committee met in Washington in April to work on promotional material and forms for national use in both the Owner-Sampler and the Weigh-a-Day-a-Month Programs. Following Kendrick's report, Ralph Hodgson indicated there were about 307,000 cows on Owner-Sampler test now, and it was hoped the Weigh-a-Day-a-Month would extend record keeping to more dairymen. He said the Dairy Husbandry Research Branch would print both the Owner-Sampler and the Weigh-a-Day-a-Month record keeping forms.

Crosby reported that the Weigh-a-Day-a-Month idea had been presented to Director of Agricultural Extension in response to a request for ways to help dairymen. Approval of the program was given and Sept. 1, 1956 was set as a date to help Extension Dairy Specialists promote the program. He also reported that Floyd Arnold would spend a month in Washington in an advisory capacity. He will help prepare additional promotional material and work with states on a district basis if needed. Brownell made a motion that the group go on record as favoring area meetings of Extension Dairy Specialists to consider testing programs with emphasis on Weigh-a-Day-a-Month. The motion was seconded by Regan and passed. Crosby asked that Dairy Specialists send other suggestions in regard to getting the program started to Floyd Arnold, Federal Extension Service, U. S. Department of Agriculture, Washington, 25, D. C.

The motion was made and passed that the forms for Owner-Sampler and Weigh-a-Day-a-Month be punched for a multi-ring binder.

LEO R. FRYMAN, *Secretary*

REPORT OF MANUFACTURING SECTION

The Business Meetings were held at 3:30 P.M., June 19, and 11:00 A.M., June 20, 1956, Chairman W. M. Roberts presiding.

Officers elected for 1956-57: H. L. Templeton, *Chairman;* F. J. Babel, *Vice-Chairman;* and B. H. Webb, *Secretary.*

Committee reports were as follows:

1. The Committee on Nomenclature and Methodology of Milk Proteins attempted "to clarify the nomenclature of milk proteins by presenting a summary of current 'preferred' usage and by showing the relationship between the individual proteins that have been isolated in the past few years and the classical milk protein fractions." A report of the committee appears in the May, 1956, issue of the Journal. Future work of the committee is to be a) a critical review of the status of some of the milk proteins, particularly those present in small concentration or of questionable occurrence, and b) a program whereby the members of the committee would check the preparation and properties of proteins reported as isolated from milk.
2. The Publicity Committee spent most of its time clarifying the procedure for getting out publicity and its relation to the Public Relations Committee of the Association. The Chairman of the Dairy Manufacturing Section is to clarify the relationship between the publicity of the Dairy Manufacturing Section and that of the Association and appoint a Publicity Committee for 1957 if it is deemed avisable.
3. The Dairy Products Judging Committee reported on the results of the contests and listed the Dairy Industry Fellows as in the table on the following page.

A subcommittee made some changes and innovations in the contest awards that are to be presented to the winners of the contest. Another subcommittee prepared and recommended tentative approval of a dry milk products score card. This recommendation was approved. It was further recommended and approved by this subcommittee that a committee composed of one member of the committee on Judging Dairy Products, one member from the Dry Milk Institute, one member from the USDA, and one member who is engaged in research on dry milk be appointed to study further the suggested score card.

4. The Committee on the Score Card for Cottage Cheese presented a proposed score card which was tentatively approved by the Section. The committee is continuing with the objective of soliciting criticisms and making any further revisions that may seem necessary.
5. The Committee on Curd Tension of Milk reported considerable progress in attempting to standardize techniques and procedures between the laboratories of the various members. The Committee is to be continued for the purpose of establishing definite practical instructions for evaluating dry milk solids processed for specific uses by the Curd Tension Method and for working out further

Team	Rank in contest	Name of team member recommended for fellowship	School selected for graduate work
Miss. State College State College, Miss. Prof. F. H. Herzer Head, Dept. of Dairying	First	L. B. Barton State College, Mississippi	Texas Tech. College Lubbock, Tex. Dr. J. J. Willingham Head, Dept. Dairy Tech.
Iowa State College Ames, Iowa Dr. C. A. Iverson, Head Dairy Industry Dept.	Second	James Riekens 208 River Ave., N. Belmond, Iowa	University of Wisconsin Madison, Wis. Dr. H. C. Jackson Head, Dairy & Food Tech.
South Dakota State Coll. Brookings, South Dakota Dr. D. F. Breazeale Head, Dairy Dept.	Third	Charles W. Sapp 610 9th Street Brookings, S. Dakota	Mich. State Univ. E. Lansing, Mich. Dr. N. P. Ralston Head, Dairy Dept.
The Ohio State University Columbus, Ohio Dr. I. A. Gould Head, Dairy Technology	Fourth	(Declined, Reassignment in process)	

details of standardizing the procedure for making curd tension measurements.

6. The Committee on Butter had no report to submit; however, it was suggested that there were many things on which this committee should be working and its continuance was approved by the Section.
7. No resolutions were submitted.

The Section expressed its appreciation to the officers and committee for their work during 1955-56.

Respectfully submitted,
W. M. Roberts, *Chairman*
H. L. Templeton, *Vice-Chairman*
F. J. Babel, *Secretary*

REPORT OF PRODUCTION SECTION

The production section business meeting was held June 20 at 11:00 A.M. with Chairman N. P. Ralston presiding.

Officers elected for 1956-57 were: *Chairman*, S. W. Mead; *Vice-Chairman*, S. P. Marshall; and *Secretary*, N. L. Jacobson.

The Dairy Cattle Judging Committee reported that the complete amended rules and regulations of the National Intercollegiate Dairy Cattle Judging Contest were published in the last volume of the Journal and that the International Dairy Show had adopted the rules and regulations of the National Intercollegiate Dairy Cattle Judging Contest as a basis for conducting the International Collegiate Dairy Cattle Judging Contest. Recommendations of the committee which were approved were: (1) That committee action to permit Fresno State College to participate in the National Intercollegiate Dairy Cattle Judging Contest be supported, and (2) that the official Rules and Regulations of the National Intercollegiate Dairy Cattle Judging Contest be amended by adding to paragraph two under Eligibility of Contestants, "An intercollegiate dairy cattle judging contest shall be defined as a competitive contest between students of two or more colleges or universities and in which official placings are made and/or prizes are awarded."

The report of the Resolutions Committee expressing appreciation to the University of Connecticut, the dairy husbandry staff of that institution, and to officers of the production section for their contributions to the success of the program was adopted.

An invitation for members to visit The Holstein-Friesian Association of America headquarters at Brattleboro, Vt., was read.

Sidney P. Marshall, *Secretary*

REPORT OF AMERICAN DAIRY SCIENCE ASSOCIATION REPRESENTATIVE TO THE NATIONAL RESEARCH COUNCIL FOR 1955-56

W. E. Krauss

The Division of Biology and Agriculture of the National Research Council continued during the past year, under the chairmanship of L. A. Maynard, to carry out many important functions aimed particularly at furthering the biological sciences and agriculture. At the same time interrelationships among this division and others of the Council assumed greater importance, since under the sponsorship of the National Academy the relationships among all the sciences must be coordinated. This is accomplished by liaison representation between and among the various divisions.

The relatively new Biology Council of the Division has been promoting a vigorous program of developing educational policies, public relations, publications, instrumentation, research support, and international conferences, and is attempting to make more and more eminent scientists available for lectures and consultation in American institutions.

During the year a rough draft of a brochure on "Career Opportunities in Biology" was prepared and each member society was asked, through its representative, to contribute $100 to the cost of printing this publication so that free distribution to high schools could be accomplished. The American Dairy Science Association did not, after due consideration, support this proposal. Most of the other thirty member societies did, except as their financial status made it impossible. It is unfortunate that the copy submitted for examination was in such rough form and that most of the illustrations were not included. The final form of the brochure, just off the press, is much different as to context and format and undoubtedly will make a greater appeal, be more widely read, and thus be of greater value in directing the interests of more students towards the biological and related sciences. Your representative recommends that this brochure again be reviewed and that the American Dairy Science Association contribute $100 toward its distribution. Any worthy effort to recruit better potential biologists warrants support and in this case could well supplement the recruitment program in progress within the Association. In dairy science more and more fundamental research is needed and much of this type of research can best be done by those well grounded in the biological sciences.

A special committee on defense has prepared a report pointing out the vulnerability of our food supply to contamination through sabotage. This report has been delivered to the Department of Defense and was defended at a special hearing.

Committees of the Institute of Animal Resources have been investigating the possibility of finding new types of laboratory animals for research uses and a sub-committee of the Committee on Animal Nutrition of the Agricultural Board is compiling a report on the nutritive requirements of laboratory animals. An attempt also is being made to provide special training for animal laboratory attendants and to improve the status of this position.

The Handbook of Biological Data, an activity of the American Institute of Biological Sciences, will soon be published. Volume I of the Handbook of Toxicology has been published (Saunders, Philadelphia). It is estimated that 17,000 scientists from all over the world provided 160,000 hours of voluntary labor toward the preparation of this fascicle.

The Food and Nutrition Board, under the chairmanship of Dr. C. A. Elvehjem, continues to be productive in the field of food protection. Through a recently acquired grant of $250,000 this Board plans to study the problem of protein malnutrition in various countries and will make liberal use of non-fat dry milk solids. A newly created Committee on Fats will prepare a report on the role of fats in human nutrition and health.

National Science Foundation fellowship applications are screened under the aegis of the Academy-Research Council. For 1956-57, 390 postdoctoral fellowship applications were reviewed and 80 awarded; 2,894 graduate fellowship applications were reviewed and 775 awarded. Fifteen of the postdoctoral awards and 157 of the graduate awards were in the biological sciences field.

Work of the Agricultural Board continued through activities of its nine committees and numerous sub-committees. Publications emanating from these committees or in preparation will be of special interest to the membership of the Association:

The Fluorosis Problem in Livestock	— (Published)
The Public Health Implications of Feed Adjuvants	— (In preparation)
Nutrient Requirements for Beef Cattle	— (Being revised)
Nutrient Requirements for Dairy Cattle	— (Being revised)
Nutrient Requirements for Sheep	— (Being revised)
Nutrient Requirements for Laboratory Animals	— (In preparation)
A Review of Bloat in Ruminants	— (Published)
The Composition of By-Product Concentrate Feedstuffs	— (In press)
Techniques in Range Research	— (In press)
Proceedings of First International Conference on the Use of Antibiotics in Agriculture	— (In press)

Information regarding the above publications can be obtained by writing Dr. LeRoy Voris, Executive Secretary, Agricultural Board, National Research Council, Washington 25, D. C.

Six new committees of the Agricultural Board have been authorized and are in the process of being formulated:

Agricultural Meteorology and Climatology
Soil and Water Conservation
Soil-water-crop Relationships
Plant Breeding and Genetics
Economics of Fertilizer Use
Plant Composition in Relation to Nutrient Deficiencies in Soils.

The Agricultural Board works closely with the Agricultural Research Institute. These two agencies jointly developed with industry the First International Conference on the Use of Antibiotics in Agriculture which was held in Washington, D. C., on October 17 and 18, 1955. About 60 foreign and 400 American scientists attended this conference. Dr. C. F. Huffman had a prominent part on the program.

The annual meeting of the Division of Biology and Agriculture was held at the National Academy of Sciences on May 11 and 12. Some of the material previously reported was reviewed at that meeting. At an interim dinner session a symposium was held on the interrelationships of the medical, biological, and agricultural sciences. W. E. Krauss, chairman of the Agricultural Board, R. Keith Cannan, chairman of the Division of Medical Sciences, and Paul Weiss of the Rockefeller Institute were the participants. It became apparent that both medicine and agriculture need the services of more biological scientists and that the biological scientists have much to contribute to both areas.

One of the most fruitful discussion periods at the annual meeting was that devoted to relationships between member societies and the Division and the role to be played by society representatives.

It was agreed that attendance at the annual meeting of the Division and then submitting a report to the Society was only one phase of a representative's responsibility. It is expected that representatives will keep in touch with activities of the Division and the Council throughout the year and report back to the Society on general activities and particularly on those of special interest to the Society. To improve this relationship the Executive Secretary of the Division will get out a monthly news letter to society representatives. From these letters items of interest may be transmitted throughout the year to the Society president or governing board. It is hoped that some space would be devoted in the society journal to items of this kind.

The hope also was expressed that the annual report of the society representative reach the entire membership either through publication in the journal or presentation at one of the sessions of the society's annual meeting (preferably not at the business meeting).

It was agreed that when committee assignments within the division are made or contemplated the President of the Society and the NRC representative be notified so that opportunity is afforded for suggestion as to competent personnel within the society membership.

Your representative has kept in touch with the activities of the Division through membership on its Executive Committee, through presiding at two meetings each of the Agricultural Board and its Executive Committee, by attendance at the annual meeting of the Agricultural Research Institute, and by participation in the International Antibiotics Conference. He appreciates the privilege of representing the American Dairy Science Association and

invites suggestions for activities within the Division that will be helpful through the Academy's resources in promoting the welfare of the Association.

AWARDS PROGRAM

The program in connection with the presentation of the Association awards and the installation of officers took place on June 21, 1956.

TEACHING AWARD IN DAIRY PRODUCTION

The recipient of the first award in dairy products teaching, which was sponsored by the National Dairy Products Corporation, was presented by K. S. Morrow.

"The committee's task in selecting the winner for the 1956 Teaching Award in Dairy Production was not an easy one. The entire list of nominations was indicative of the exceptional talent that is associated with the responsibility of teaching students in the various fields of dairy science.

"The recipient of this first Dairy Production Teaching Award was born on a farm in Minnesota. At an early age he found himself associated with dairying, as he helped milk up to 32 Jersey cows by hand daily while attending high school. Majoring in dairy husbandry, he received his B.S. degree in Agriculture at the University of Minnesota in 1916. His special interest in the dairy sciences encouraged him to secure an M.S. degree in 1917 at the same institution. After spending three years as a dairy extension specialist at Kansas State Agricultural College, where he was active in developing the early dairy extension program in that state, he returned to Minnesota where he joined the department staff in 1921 and from which institution he received his Ph.D. in 1928.

W. E. Petersen

"Recognized nationally and internationally for his research accomplishments in the field of dairy science, his reputation as an outstanding teacher is of no less distinction. To comparatively few has come the privilege of influencing the lives of so many students. Thirty-five years in the classroom has brought him in contact with thousands of students. He has served as faculty adviser to over 400 undergraduates, and over 100 graduate students have received advanced degrees under his guidance.

"His unusually keen mind, his imaginative philosophy and distrust of the conventional, his unquenchable enthusiasm, and his colorful personality have been a source of stimulation and inspiration to those to whom he has been a teacher and counselor. But the benefits of his teaching have not been confined to the four walls of the classroom or laboratory. Farm audiences and dairy and scientific groups from coast to coast in the United States, in Canada, Mexico, South America, in Europe, and in New Zealand and Australia have come to regard him 'as being one of the great dairy science teachers of this age.'

"He has developed special teaching aids. The sole author of the standard college textbook *Dairy Science*, and co-author of six other textbooks on agriculture, he has also produced two motion pictures dealing with the science of milk secretion and has participated in weekly radio broadcasts on dairy subjects for over 13 years.

"Our candidate for the award has served the American Dairy Science Association as a member of the editorial board, as abstract editor, as director, and as president. In 1942 he was the recipient of the American Dairy Science Association Borden Dairy Production Award.

"On behalf of the Award Committee it is my pleasure to present as the candidate for the first Teaching Award in Dairy Production, Dr. William Earl Petersen, Professor, Department of Dairy Husbandry, University of Minnesota."

DE LAVAL EXTENSION DAIRYMAN AWARD

The citation for the award given for outstanding work in dairy extension was read by Lynn Copeland.

"Our selection for the De Laval Extension Award for 1956 has had an unusual career. First, due to limited finances and farm work at home, he never had the opportunity of attending high school. He was born and raised in Wisconsin and did manage to attend two winter short courses at the University of Wisconsin and then worked on neighboring farms for the next three years. In 1909 he read an advertisement in *Hoard's Dairyman* that changed his entire life. This advertisement was for a dairy herdsman at Montana State College. He applied and got the job. Then he proceeded to spend all his evenings

J. O. Tretsven

studying high school subjects and in 1917 was permitted to enter college as a part-time student while still holding his position as herdsman. He obtained his B.S. degree when he was past 30 years of age. In 1932 and 1933 he took sabbatical leave and obtained his M.S. degree from Washington State College.

"In 1922 he was appointed part-time dairy specialist, serving also for some time as head of Dairy Production at the College. He continued in this dual capacity for some years, but since 1945 he has devoted all of his time to Dairy Extension activities. In the 34 years that he has served the dairy farmers of Montana, he has developed and carried out a sound, practical program, geared to the needs of the state, and he has done all of this, working alone.

"Among the major extension activities that he has developed and promoted have been mastitis control and prevention, Dairy Herd Improvement Association work, open-shed housing and milking parlors adapted for the northern states, called the Montana-type milking parlor, metal, nipple calf-feeding buckets during wartime, holding many market milk schools to improve milk quality, plus many feeding schools and numerous other dairy extension activities.

"His writing was quite prolific. He has published numerous bulletins, leaflets, and many timely dairy articles for Montana papers. He is very popular in his state and highly regarded by the farmers and dairymen of Montana, and because of this he has been honored locally on several occasions. Last September, our candidate reached retirement age. However, since a successor could not be found, he has continued on, and today is still very much on the job.

"It is my very great pleasure to present the choice of our committee for this distinguished award, Professor J. O. Tretsven, Extension Dairyman for the state of Montana."

AMERICAN FEED MANUFACTURERS' AWARD

J. W. Thomas presented the committee's choice for this award in the following words.

"The man your committee has selected to receive the American Feed Manufacturers' Association Award for this year is very likely the most versatile man in the American Dairy Science Association. His numerous ventures pertaining to nearly every imaginable phase of dairy cattle nutrition have been notably successful. The results of his work have received wide acceptance.

"He was born and educated in Iowa and received his B.S. degree from Iowa State College. He was in extension work in South Dakota for two years before starting his graduate training. He received his M.S. degree from Montana State College and his Ph.D. degree in dairy husbandry from the University of Minnesota. He remained on the staff there for two years. For the next five years he was a member of the staff of the University of Connecticut. He then moved near our nation's capital where he is as well known in business and in social and diplomatic circles as he is to us.

J. C. Shaw

"During the period for which this award was made, the recipient and his associates published 13 papers in six distinct fields of dairy cattle nutrition. These investigations have dealt with practical applications and theoretical considerations in each field. He is actively engaged in, and has published results of, investigations in the popular field of bloat in cattle. His work has included investigations on the effect of soybeans on the metabolism of carotene and vitamin A in dairy animals. The role of neutral fat and its formation in the udder have been thoroughly investigated by our candidate. In the field of rumen bacteriology the fundamental studies by this worker and his colleagues are outstanding. Our understanding of the influence of hormones on the physiology of milk production has increased enormously from the investigations of this man. This award cites his work on the effect of pituitary hormones on milk production and the effect of adrenal hormones on metabolic diseases of the milking cow. His continuing efforts to clarify the metabolic disturbance that causes ketosis and the related practical studies deserve special commendation.

"Our candidate received the Borden Award in Dairy Production in 1947. By now you all have recognized the winner of this award as the eminent Dr. J. C. Shaw.

"On behalf of the award committee it is a great pleasure to present Dr. Shaw as the candidate of the American Dairy Science Association for the 1956 American Feed Manufacturers' Association Award."

HONORARY MEMBERSHIP AWARD

The citation for this year's honorary member award was given by H. B. Henderson, as follows:

"Our Honorary Member was born in a two hundred-year-old colonial house on a farm called "Little River," near the village of Kingston, New Hampshire. His childhood was that of a typical New England farm boy. When he was old enough he helped out with the chores and also contributed what service he could in the operation of his father's grist mill. Upon graduation from the University of New Hampshire in 1911 he was employed by the Department of Entomology of that institution. There is some question as to which task occupied the most of his time, chasing gypsy moths or a young lady by the name of Alice Bates, who became his wife a year later.

H. F. Judkins

"In the fall of 1912 our honorary member accepted a position as instructor in the Dairy Department at New Hampshire, from which he resigned to take a similar position the following year in the Dairy Department of Connecticut Agricultural College, now the University of Connecticut. In 1918 he moved westward to Ames, Iowa, where he accepted the appointment of associate professor of dairying at Iowa State College. He was rapidly growing in stature as one of the leading dairy manufacturing instructors, and a year later he returned to New England, this time as a member of the staff of the Dairy Department of the University of Massachusetts, then known as Massachusetts Agricultural College. A short time later he was appointed head of the Dairy Department of that institution.

"While at Massachusetts our honorary member made quite a name for himself with his ice cream short course and other activities helpful to the New England ice cream industry. He also found time to write and publish a book on dairying, which many of those assembled here have used as a textbook.

"In 1925 Eastern Dairies needed someone to take charge of their Research and Production Department. In 1928 this organization merged with General Ice Cream Corporation. Shortly afterward the new organization became a part of the rapidly expanding National Dairy Products Company, all of which increased the scope and importance of his activities.

"In 1931 our honorary member was called to New York to become Director of Production for National Dairy Products Corporation. He organized and developed this new department and helped coordinate its activities with those of the newly created Research Laboratories of National Dairy, then located in Baltimore.

"In 1935 the Sealtest System of Laboratory Protection was created and our Honorary Member was named Vice-President and later became its President. In October, 1949, the functions of Sealtest, Inc. were taken over by National Dairy Products Company. He then became a Vice-President of this company. His range of activities and interest expanded still further from sanitation, plant housekeeping, and product quality to work simplification, reducing plant losses, and entomological control. He has also devoted much time and attention to training young men for leadership in the dairy industry.

"He has received many honors and awards for his contribution to the dairy industry. He served as president of the American Dairy Science Association in 1941-42. His counsel and advice have been constantly sought by such organizations as the U. S. Public Health Service, the International Association of Ice Cream Manufacturers, and the Milk Industry Foundation.

"Our Honorary Member has been described as 'a crusader—one who has spent his life working for a cause. In his case it has been to improve sanitation, plant housekeeping, and product quality in the dairy industry.' Another has said, 'This man would have made a great evangelist.' No one who has known him intimately can forget the warmth of his personality, his philosophical good humor, the vigor of his opinions, nor the wisdom of his judgments.

"Upon his retirement from National Dairy in March, 1955, he was elected Secretary of the American Dairy Science Association as of July 1 of that year.

"Will Mr. Henry Forrest Judkins please come forward."

BORDEN AWARD IN DAIRY MANUFACTURING

"The recipient of the 1956 dairy manufacturing award was presented by F. J. Doan.

"The recipient of the 1956 Borden Award for dairy manufacturing research has been en-

gaged in dairy products research and instruction for more than 28 years. His studies, both fundamental and applied in character, have covered a wide variety of problems related to the processing and handling of dairy products: the Minnesota Test and reagent; microorganisms deteriorating butter, viscosity of cream, density of milk fat; accuracy of fat analyses; fat accounting in plants; in-place cleaning of separators; relation of oxygen to oxidized flavor and ascorbic acid loss in milk; behavior of antioxidants in cream, ice cream, and dry milk; effect of light and protective containers on milk vitamins; and design of laboratory lyophilizing equipment.

E. O. Herreid

"He has served continuously on A.D.S.A. committees since 1930; is chairman of the nominating committee this year; and was particularly active in the formulation of uniform standards for testing milk. He was war-time consultant to the USDA and the War Production Board and is now A.O.A.C. associate referee on fat in dairy products and a member of the National Research Council subcommittee on dairy, oil, and fat products.

Recently his available time has been devoted to research in an area of increasing interest to the dairy industry—high-temperature pasteurization and sterilization of dairy fluids. These studies have included equipment and methods development, lethal time-temperature relationships and heat effects on the physical, chemical, and nutritive character of products. His findings, and others like them, are basic to the further employment of high-temperature processing by industry.

"This year's recipient is a native of South Dakota. He obtained a bachelor's degree at South Dakota State College in 1927 and master's and doctor's degrees at the University of Minnesota in 1928 and 1933, respectively. After serving on the dairy staff at Minnesota for 7 years he spent 9 years at the University of Vermont in a similar capacity. In 1945 he moved to his present position as professor of dairy technology at the University of Illinois.

"It is my great pleasure to present to you Dr. Ernest O. Herreid."

BORDEN AWARD IN DAIRY PRODUCTION

Samuel Brody presented the winner for the dairy production award.

"The 1956 recipient of the Borden Award for outstanding research in dairy production was reared on a dairy farm near Hannibal, Mo. He obtained from the University of Missouri the degrees of B.S. in Agriculture in 1929, M.A. in 1931, and Ph.D. in 1936 (dissertation: Growth and Development of Dairy Calves on a Milk Diet). As undergraduate at the University of Missouri he worked as milker; was a member of the judging team competing at the Dairy Cattle Congress and National Dairy Show; was a member of the College Farmer (student paper) staff; and a member of Alpha Zeta.

H. A. Herman

"He was a member of the staff of the Department of Dairy Husbandry, University of Missouri (assistant instructor, 1929; instructor, 1930; assistant professor, 1936; associate professor, 1942; professor, 1945 to 1953). Since 1953 he was Executive Secretary of the National Association of Artificial Breeders (NAAB), editor of the NAAB journal (which carries extensive reviews of literature), director of its Research Council and coordinator of research among the member organizations.

"The major contributions for which the recipient of this award is being recognized are in the field of artificial insemination and physiology of reproduction in cattle (variation in semen quality; bacteria in semen; estrous cycle; histochemistry of reproductive tract; semen extenders; age-fertility relation; season-fertility relations). His earlier researches were concerned with the nutrition of cattle (value of milk as sole diet; rumen microorganisms; value of Korean lespedeza proteins; digestibility of roughages; site of conversion of carotene to vitamin A; the value of carbohydrates in aiding microbial digestion of crude fiber; the mineral content of Missouri roughages; effect of nutritional level on growth; maximum roughage utilization; temperature and milk composition).

"On behalf of the Awards Committee for the Borden Award for Dairy Production, it is my pleasure to ask Dr. H. A. Herman of the University of Missouri to come forward to receive this Award for 1956."

INSTALLATION OF OFFICERS

President Gould installed the following Association officers: G. M. Werner and E. H. Parfitt, directors; D. V. Josephson, vice-president; and C. F. Huffman, president.

THE GOLDEN JUBILEE PLATFORM OF THE AMERICAN DAIRY SCIENCE ASSOCIATION

Adopted at the 50th Anniversary Meeting of the Association, Storrs, Connecticut, June 19-21, 1956

The American Dairy Science Association, being the leading educational, scientific, and professional organization in the dairy industry, believes that the Golden Jubilee year is an appropriate time to state its position with reference to this great industry.

The Association recognizes that many of the major modern-day problems are of mutual concern to the various segments of our industry and may be treated adequately only by full cooperation between all interested agencies and organized groups. Therefore, the Association takes this occasion to emphasize its desire to cooperate with other organized groups in programs designed to further the welfare of the dairy industry, programs which relate particularly to classroom and adult education, to fundamental and applied research, and to the development of industry leaders.

One of the main functions of the Association is to foster research and to disseminate research information through the *Journal of Dairy Science*, which is distributed throughout the world. The Association takes cognizance of the fact that research is responsible for the present well-being of our industry and will determine its future progress.

That there is a shortage of well educated dairy school graduates qualified for responsible positions in the commercial industry, in educational institutions, and in federal agencies is well recognized by the Association and industry alike. Since the members of the Association are the educational leaders of the industry and are those who must, of necessity, be responsible in large measure for the recruitment of secondary-school students, for their dairy education, and for their eventual placement, it appears logical that the Association be considered as an active cooperator with other industry groups in all steps taken to further the recruitment for the dairy industry of secondary-school students.

In respect to attracting a larger number of superior young people into the dairy industry, the Association has taken the initiative by publishing in the *Journal of Dairy Science* (September, 1955) a report entitled "A Guide for Secondary School Recruitment Programs in the Dairy Industry." It recommends this for general use. At the 1955 meeting of the Association, a resolution was adopted calling the attention of dairy organizations and companies to the need for a public relations and recruitment film and offering the cooperation of the Association in its production. Films and printed material are vital tools of communication needed to convey to the secondary-school student the story of our industry and the opportunities it offers. No time should be lost in obtaining full cooperative effort to produce this recruitment material and to make effective use of it.

The Association recognizes the need of the commercial industry for better organized and more effective training and development programs for the college graduates. An Association Committee on Personnel Training and Development, consisting of university and industry members, is preparing a manual suitable for use by companies comprising the industrial phase of dairying.

The Association is aware that it must keep abreast of the times in its educational objectives and teaching techniques. A permanent Education Committee has been established and has embarked upon an ambitious program designed to assure adequate education of dairy students for leadership in science and industry. A symposium was arranged by this Committee for the Golden Jubilee meeting in Connecticut on "Educational Objectives in Dairy Science." To encourage continued improvement in teaching, a Teaching Award of $1,000 is made available each year through the Association to an outstanding teacher in dairy science.

The Association acknowledges that dairying is basically a science area and that there is a great shortage of scientists. The Association believes that the quality and value of research work in the dairy industry will be enhanced by more thorough education of American youth

possessing exceptional potential ability and is exerting its efforts to interest more of such students to study for advanced degrees. Three awards of $1,000 each are presented each year through the Association for original research by its members for the purpose of encouraging and recognizing research accomplishments.

The Association believes that no time should be lost in putting the results of the research of its members to work to the fullest extent. Those members of the Association engaged in dairy extension work are meeting this challenge. To recognize effective adult education endeavors, a special award of $1,000 is given annually through the Association to an outstanding dairy extension specialist.

The Association believes that the full appreciation of the contributions of science to the advancement of the dairy industry has not been realized by either adults outside of the field or by potential college students in dairying. Therefore, it recommends that full attention of all segments of the industry be given cooperatively to a national program designed to inform the public at large of the importance of science to the success of the dairy industry—and thus to the welfare of the nation.

OUR INDUSTRY TODAY

Brief Reviews of Current Topics

The Miracle of the Dairy Cow

R. E. Hodgson

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All through history the cow has provided man with milk, one of his most important foods. The cow was one of the first of the domesticated animals, and man has taken this trusted bovine with him wherever he has migrated. He has always used the cow as a source of food, both milk and meat, and as a beast of burden. Great industries have been developed, based on the product of the cow. Man's advancement in intelligence, physical development and health, and in his material achievements has been accompanied with advancement in the development of the dairy cow. Wherever great and progressive societies have developed, there also is to be found a great and progressive dairy industry.

Milk is man's most important food. It is the most complete food available to him. Milk is a food common to all people, and in most countries cow's milk is relied on to supplement or replace mother's milk as the first and only food to supply the essential nutrients for the infant and early childhood period. It is equally important to the growing adolescent and to the adult of all ages. The importance of milk as a food makes its synthesis and secretion in the cow's udder one of the greatest of miracles, duplicated no place else in nature, and accords the dairy cow the distinction of being the foster mother of the human race.

Historical Development of the Dairy Cow

The history of the origin of cattle is obscure. Although cattle were no doubt of common ancestry, historians early differentiated this species of bovine into two classes, the *Bos taurus* (and *longifrons*) and the *Bos indicus*. The former are the progenitors of the present-day breeds emanating from Europe, and the latter, "the humped cattle," came from India and the East. Through gradual evolution, as man applied his knowledge and skills, and by reason of isolation, various types of cattle evolved that more closely fitted the needs of people in particular localities. Little is known of the methods used in the early development of these types. Mendel's "Laws of Inheritance" were not known until the beginning of the 20th century. In spite of lack of knowledge of genetics, however, specific useful types were developed.

It was in the middle of the 18th century that Bakewell and his contemporaries in England undertook systematic methods of breeding to improve the utility value of cattle. He proceeded on the principle of "like begets like" and his methods were to breed the "best to the best," although there is evidence that long before this the Dutch and Friesians had made considerable progress in developing the Friesian (known to us as Holstein-Friesian) to a high utility value for milk and meat production. Bakewell apparently used some imported Friesians, which he crossed with domestic cattle. The resulting crosses were used in developing the foundation for the Hereford breed. It was through similar efforts by pioneer breeders in Europe, the Channel Islands, and Britain that the present breeds of dairy cattle and beef cattle, as we know them today, were developed.

Introduction of Cattle to America

The early voyagers to the Western Hemisphere brought cattle with them and introduced the bovine to the new world in the early 1600's. These first cattle came from the Iberian Peninsula with the Portuguese and Spanish explorers. British and Dutch colonists brought cattle from their homelands to the Virginia, New England, and New York areas in the early part of the 17th century.

The Iberian cattle were spread through the southern part of our country and were the foundation of the famous Texas Longhorn and other native types, and those of the British and Dutch colonists for the most part were spread through the northern part of the country. These early cattle did not contribute much to the dairy cow population other than as a base for grading up with improved stock.

The recorded history of the development of America and the opening and settlement of the Plains and the West depicts the importance that our forefathers attached to the cow and the important contribution that the cow has made to the development of our country.

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The foundation stock that produced the present dairy cattle came from already improved pure breeds that have been imported since the beginning of the 19th century from Europe, the Channel Islands, and Britain.

There Are Several Breeds of Dairy Cattle

The present dairy cow population is made up of seven recognized breeds: Ayrshire, originating in Scotland; Brown Swiss, originating in Switzerland; Guernsey, originating on the Isle of Guernsey; Holstein-Friesian, originating in the Netherlands; Jersey, originating on the Isle of Jersey; Milking Shorthorn, originating in England; and the Red Dane, originating in Denmark. Only a small percentage of the cow population are purebreds of one or the other of these breeds. The great majority of the dairy cows are known as grades. Grades are animals that resemble in color and conformation one or the other of the pure breeds but because one of the parents, usually the mother, was not of purebred or registered stock they are not eligible for registry in the herd books of the breed societies.

The various breeds were developed in their respective homelands because of particular circumstances of climate, feed supply, and food needs of the people. For example, the Ayrshire was developed into a hardy, rugged animal of about 1,150 lb. in size, particularly suited to the harsh climate and the grazing of rough pasture lands characteristic of Scotland. The Holstein-Friesian, one of the largest of the dairy breeds, weighing about 1,500 lb., was developed in the Dutch lowlands where abundant pasturage, easily accessible, was available. The Dutch breeders emphasized bigness in their animals so that they could consume lots of grass and produce large amounts of milk of low butterfat content, especially suitable for cheese making. On the other hand, the Jersey was developed into a small, refined breed of about 1,000 lb., to fit the small compact pasture lands characteristic of the little island of Jersey. Since the export of butter to nearby England was important in the island's trade, the breeders developed the Jersey into an animal that produced milk of a high butterfat content.

As the numbers of purebred animals imported into this country, and their descendants, increased and the native cow population graded up through the use of purebred bulls, the cow population took on the characteristics of the several distinct breeds. The various breeds became popular in the several localities where their respective qualities seemed to fit best. For instance, the big Holstein-Friesian that produced a lot of milk developed around the centers of big population where large, fluid milk markets existed, and in areas of abundant feed supplies. The Jersey, on the other hand, became most popular in the outlying areas where buttermaking was the chief market for milk. Jerseys also became the breed of the South because they were better able to stand the high temperatures of that area, and because of their small size they did not require as large a feed supply. In more recent times, because of changing economic conditions and improvements in transportation that facilitated the movement of milk and milk products, each of the recognized breeds is to be found in all parts of the United States, and personal preference is a larger factor governing their distribution.

The Dairy Cow Performs a Unique Function

The dairy cow is unique among all the animals that are useful to man. This is because of the use she makes of two important, well-defined, highly-developed organs in her complex anatomy, the rumen and the mammary gland or udder. The rumen, which can be likened to a large storage and fermentation vat, enables her to consume, store, and utilize large amounts of coarse feed materials not suitable for direct use by humans. Myriads of microorganisms live in the rumen and, owing to their activity, they aid the cow in breaking down, digesting, and utilizing nutrients contained in these types of feeds. This makes it possible for the cow, in a large measure, to sustain herself on bulky forages that are not particularly suitable to nonruminant animals.

An equally important and unique organ is the udder. The udder enables the dairy cow to use, with a high degree of efficiency, the nutrients derived from such feeds in the manufacture of large amounts of milk, man's most important food.

It is something of a miracle to realize that through the efforts of the breeders the dairy cow has been developed to a point where she is able to produce large quantities of milk. This has been made possible through continuous mating of like animals and selecting for breeding purposes animals that have good milk-producing ability. In this development the udder, the primary function of which is to secrete enough milk to nourish the young until they are old enough to fend for themselves, has been developed to a point where it secretes many times as much milk as is needed for the calf. The period of lactation between calvings has been extended from a few months to 10 months or more.

How Milk Is Made

The udder of the modern dairy cow is one of the largest and most important secretory tissues of the animal body. The udder consists of four independent glands commonly known as the quarters. Each quarter is supplied with a teat. Desirable-shaped udders are large, symmetrical, smooth, well balanced, and firmly attached to the body of the cow, with four teats of uniform size squarely and evenly placed at the bottom of each quarter. The cow shown in Fig-

ure 1 possesses what dairymen consider a desirable-shaped udder.

The interior of the udder, as shown in Figure 2, consists of a teat canal, a milk cistern, and a large ramification of tubules extending throughout each quarter. Surrounding these tubules are enormous numbers of cells making up the secretory tissue. The secretory tissue, as well as

FIG. 1. A typical dairy cow with a well developed udder. She has produced 134,040 lb. of milk and 5,491 lb. of butterfat in six lactations.

the other tissues of the udder, is abundantly supplied with blood, nerves, and lymph vessels. The blood vessels supply enormous quantities of blood to the udder. It is said that between 400 and 500 gal. of blood pass through the functioning udder for each gallon of milk secreted. The blood brings to the secretory cells the ingredients, amino acids, glucose, fatty acids, minerals, vitamins, and other materials which the secretory tissue cells use in the manufacture of milk. Just how these materials are transformed into milk is not known, but it truly is a miraculous phenomenon and one of the great wonders of the world we live in. Casein and lactose, both of which are important constituents of milk and which have unique nutritional properties, are produced nowhere else in nature.

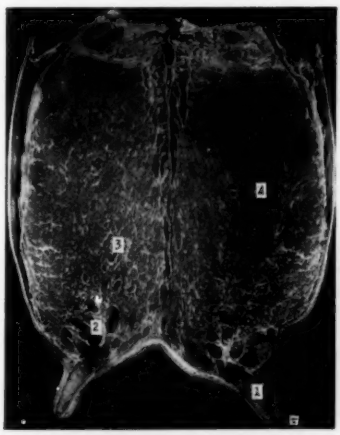

FIG. 2. A cross section showing interior of udder of a dairy cow. 1, teat canal; 2, milk cistern; 3, milk tubule; and 4, secretory gland.

In the lactating cow milk secretion is a continuous process. The milk produced by the secreting cells is passed into the tubules and spaces of the udder. The rate of secretion is fastest after milking and virtually ceases when the udder becomes full. When milking begins, the cow's nervous system causes a release of a hormone, oxytocin, from the anterior pituitary located at the base of the brain. This material passes through the blood stream to the udder and increases the pressure in the udder so that the milk is forced into the teat cisterns, from which it is delivered through the teat canal at milking. This stimulus to let down milk lasts only from 3 to 5 minutes at any one time, but this is long enough to take as much as 40 to 50 lb. of milk from high-producing cows.

The Composition of Milk

The milk produced by the individual cow or by cows of the same breed is relatively uniform in composition. This is true with the exception of vitamin A and a few other nutrients that vary according to the type of feed the cow consumes. The milk of the different breeds of cows varies to some extent in fat, solids-not-fat, energy value, and certain vitamins. The average composition of milk from cows of the different breeds, of average milk, and of colostrum milk is given in Table 1.

The first milk that is secreted after parturition and that the calf receives at birth is called colostrum. It has a different appearance and composition from normal milk (see Table 1). Colostrum is much higher in solids, fat, protein, and most of the vitamins important to the calf. The proteins consist of a much higher percentage of albumin, and particularly globulin, in relation to casein than is found in normal milk. The amino acid, tryptophan, and the vitamin A contents are much higher. The colostrum is, in fact, a prepared food especially suited as the first feed of the newborn calf to provide it with the essential nutrients to start it on its new life. It also has a favorable influence on the calf's digestive organs. The albumins and globulins impart protective substances to the calf to help it guard against certain diseases. Thus, the mammary gland performs the unique function of secreting a special food for the newborn and then later of secreting what we know as normal milk, both of which suit the needs of the calf at particular stages of its life. Just how this is brought about still remains a mystery to scientists. The composition of the colostrum gradually changes until in a few days it assumes that of normal milk.

Milk is well supplied with protein of a unique amino acid content. Protein makes up a vital and important part of the composition of the

TABLE 1
Average composition of cow's milk[a]

Breed	Water	Total solids	Fat	Protein	Lactose	Ash	Calories[b]
	(%)	*(%)*	*(%)*	*(%)*	*(%)*	*(%)*	*(Per lb.)*
Ayrshire	86.95	13.05	4.05	3.51	4.81	0.68	321.7
Brown Swiss	86.61	13.39	4.10	3.48	5.09	0.72	329.1
Guernsey	85.49	14.51	4.90	3.90	4.97	0.74	369.1
Holstein-Friesian	87.68	12.32	3.45	3.30	4.89	0.68	294.5
Jersey	85.14	14.86	5.37	3.79	5.00	0.70	382.3
Milking Shorthorn	87.43	12.57	3.63	3.32	4.89	0.73	302.7
Average milk	87.20	12.80	3.70	3.50	4.90	0.70	320.0
Colostrum milk[c]	73.01	26.99	5.10	17.57	2.19	1.01	776.3

[a] *Feeds and Feeding*, F. B. Morrison, 21st ed., p. 692. Ithaca, N. Y. 1948.
[b] Caloric value calculated by using following calorie per gram factors: fat × 9.25, protein × 4.27, and lactose × 3.87 (Table 13, USDA Agr. Handbook No. 74, 1955).
[c] From Table 2, The Composition of Milks, National Research Council Bull. 254, Rev. 1953.

body. Nine amino acids are essential and need to be supplied in food. Seven of the essential amino acids are present in milk protein to some degree, and 17 of the 21 known amino acids are found in milk. This is why milk is so valuable as a source of protein. The milk protein effectively supplements less complete proteins in other foods and is highly digestible.

Milk is well supplied with many of the minerals needed for proper nutrition, most important of which is calcium. This is true because calcium is needed in large quantities for bone growth and for the maintenance of vital tissue processes. Because most other foods commonly included in the diet are low in calcium, milk and its products, except butter, are depended on as the principal source of this nutrient for humans.

Another important group of nutrients found in milk is the vitamins. Vitamin A and carotene both contribute to the vitamin A value of milk. Milk is an important dietary source of this vitamin. The vitamin A value of milk varies with the amount of carotene in the feed that the cow eats. When given feeds high in carotene, the vitamin A value of the milk is high, and when feed low in carotene is given, the milk is low in vitamin A. Under usual conditions, the vitamin A value of milk produced by cows on barn feed during the winter is only 50 to 70% as high as that of milk when cows are on pasture in the summer.

The vitamin D value of milk is rather low and relatively constant. Scientists have developed ways of fortifying milk with this vitamin, and today most of the market milk has a minimum content of 400 units per quart.

All of the known water-soluble vitamins, especially those of the vitamin B complex and including B_{12}, are present in milk in rather uniform amounts. This is due to the fact that the microorganisms that populate the rumen of the cow synthesize these vitamins and they are absorbed by the cow and secreted in the milk.

Nutritionists consider milk one of our most complete foods. Liberal amounts of milk are basic to a well balanced diet. It effectively supplements all other ingredients used in the food supply. Nutrition and medical specialists express the opinion that our people do not use enough milk in their diets for optimum nutrition. It is considered that each individual ought to take at least three glasses of milk daily. Many research studies have brought out facts that argue for milk as an excellent and economical source of many of the essential food nutrients. Much of our knowledge of nutrition has been built on results of research on milk. Whenever a new nutrient or a new vitamin has been discovered as essential for nutrition, that nutrient or vitamin invariably has been found in milk. No doubt as further essential nutrition elements are discovered they also will be found in milk. The miraculous thing is that the cow is able to manufacture, from the materials that she consumes in her feed and which are brought to the udder by the circulatory system, so many of these essential nutrients and to put them in milk in such goodly balanced proportions.

That milk is valued as a food by the people of this country is evidenced by the fact that it occupies such a prominent place in our food

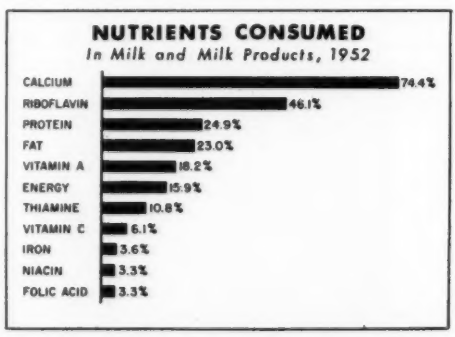

FIG. 3. Percentage of total nutrients contributed to consumer's food supply by milk and milk products in 1952. (From USDA Agr. Handbook No. 62, 1953.)

supply. The contribution that milk and milk products make to the average diet is shown in Figure 3. The per capita consumption of milk and its products during the past three decades is shown in Figure 4. Even though a large amount of milk is used in our diets, comparatively the peoples of many other countries consume it in considerably larger amounts than do we. Comparative statistics of the per capita consumption of milk and its products (on a milk equivalent basis) are shown in Figure 5. It would appear that in this respect much work is yet to be done to increase the use of milk and its products in the diets of our people. This ought to be accomplished because on a nutrient basis milk and whole and skimmilk products are economical foods.

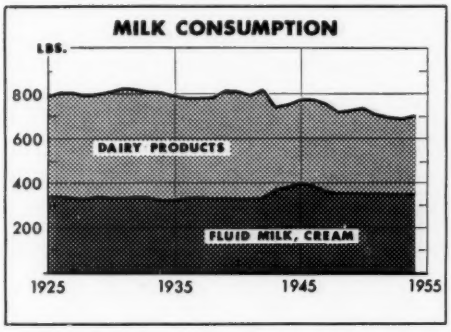

FIG. 4. Per capita consumption of fluid milk and cream and of milk products (milk equivalent) in the United States by years. (From Milk Production on Farms and Statistics of Dairy Products—1954. USDA, Agr. Marketing Service, Washington, D. C., Feb. 1955.)

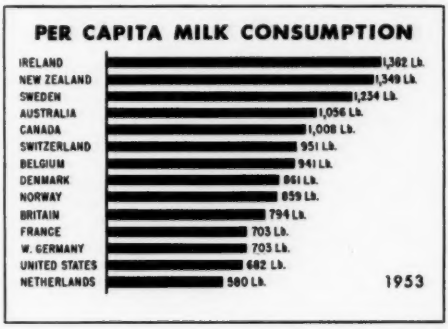

FIG. 5. Per capita consumption of milk and milk products (milk equivalent basis) for different countries in 1953. (From Foreign Agriculture Cir. F.O. 10-55. USDA, Washington, D. C. 1954.)

Economic Importance of Dairying

Dairy farming has flourished in the United States, particularly since the beginning of the 20th century. It has grown into the largest single agricultural industry. There were more than 3.6 million farms on which milk cows were kept in 1950. The importance of dairying can be shown by the investment in land, buildings, equipment, and stock used for dairy purposes, as compared to the total investment for all farm enterprises and the value of the milk produced in total and as a per cent of gross farm income. Table 2 gives this information over the period from 1925 to 1950.

There are many reasons why dairy farming has reached such importance. Perhaps the most important is the fact that scientists and medical people have found that milk is the most nearly perfect food for man. A second reason is that the farmers and the processors, manufacturers, public health officials, veterinarians, and others have developed production and processing procedures that have enabled the milk industry to make available to the consumer a uniform, high-quality milk that is fresh, wholesome, safe, and highly palatable. A third reason is that the dairy cow is among the most efficient of all farm animals in converting the feed that is not particularly useful to man into a product of high market value and nutritional quality. Comparative data to bear out this fact are given in Figure 6. A fourth reason is that dairy farming

TABLE 2

Value of real estate, equipment, and cattle for milking herds and the farm value of milk produced in the United States (Millions of dollars)[a]

Year	Value of land, buildings, and equipment used for milking herds	Value of milk cattle for breeding and replacement purposes	Combined value of real estate, equipment, and breeding cattle for milking herds		Farm value of milk produced	Per cent of gross farm income
			Total	Per cent of all farm total		
1925	8,908	1,297	10,205	17.8	2,083	15.3
1930	10,775	2,315	13,090	22.6	2,104	18.4
1935	7,715	941	8,656	22.5	1,740	18.0
1940	8,087	1,777	9,864	23.5	1,931	17.7
1945	9,451	3,407	12,858	20.9	3,673	14.5
1950	13,845	5,488	19,333	21.5	4,432	13.8

[a] Bur. Agr. Econ., USDA 1950.

always has been a stable occupation that provides a steady income throughout the year. A fifth reason is that dairy cows, by virtue of their ability to sustain themselves on a high forage ration, encourage the growing of grass and legume crops, thus promoting good land use practices and soil conservation on our farm

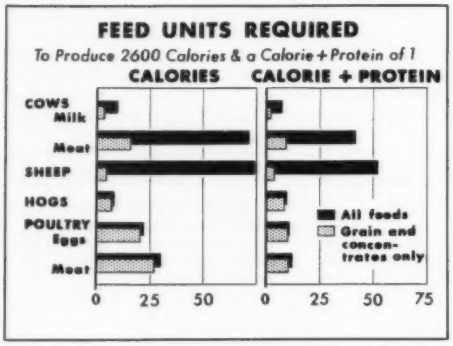

FIG. 6. Relative efficiency of various farm animals in converting feed nutrients to food nutrients. (From USDA, Cir. 670, 1943. An index giving equal weight to calories and protein in a food in terms of the daily requirements of the human for these nutrients, i.e., 2,600 calories and 0.15 lb. of protein and assuming each nutrient of equal importance. A food is evaluated by the calories and protein it contains in terms of the daily requirements and the sum of the two equals the index of the food.)

land. A sixth reason is that dairying fits in well with a diversified farm enterprise, which encourages the maximum use of farm and owner resources.

Dairy farming is practiced in every part of the United States and contributes substantially to the farm income and welfare of the people. It is concentrated particularly in the humid and semi-humid or so-called grassland regions and in areas of great concentration of human population. The national dairy herd on January 1, 1955, consisted of 37 million head, 24.4 million cows two years old and over, 6 million heifers one to two years old, and 6.6 million calves under one year of age. The milking cows produced a total of 123.4 billion pounds of milk in 1955, or an average of 5,815 lb. each. This was enough milk to furnish each person with 747 lb. About one-fifth of the food nutrients consumed by the average person came directly from milk or from milk products. This truly is a miraculous achievement for the dairy cows of this nation. This noble beast, the real queen of the American countryside, has served her masters well and has filled the consumer's cup to overflowing with nature's most refreshing and healthful food. Whether she is clothed in the golden cream color of the Guernsey, the fawn color of the Jersey, the brown of the Swiss, the black and white of the Holstein, or the red and white of the Ayrshire and Milking Shorthorn, she has earned her keep, and more, by transforming the raw materials—the grasses and legumes—grown on the farmer's soil, into a readily marketable product important to every man, woman, and child. In addition, she provides employment for about one-seventh of our people.

How Did Cows Achieve Present Position?

The development of the dairy cows into this position of importance in our national economy is evident from historical records. This is portrayed in Figure 7, which shows the number of

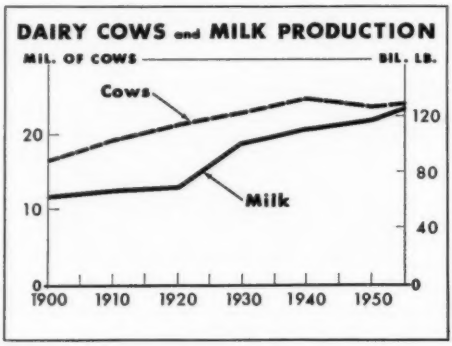

FIG. 7. Number of dairy cows 2 years old and over kept for milk and total yearly milk production in the United States. (From Statistics on Livestock Numbers, Agricultural Marketing Service, USDA, Washington, D. C. 1955.)

milk cows and the total yearly milk supply at intervals from 1900 to 1955. In this time the average yield of milk per cow has increased from about 3,600 lb. per year in 1900 to over 5,800 lb. in 1955. This is enough milk according to current rates of consumption for each cow to supply the needs of eight people. Thus the development of the lactating function of the dairy cow has progressed steadily, each generation of animals on the average being higher producers than their parents. Steady improvement in the producing ability of the total dairy cow population and in their feeding and care, coupled with an ever increasing market for milk and its products, has made this advancement possible.

Compared to the average cow, there are many individual cows that have produced much greater amounts of milk and butterfat in a year's time. A Holstein-Friesian cow holds the world's record for production of milk by producing 42,805 lb. in a year. At the 1954 rate of consumption, this is enough to furnish milk for 61 people for a year. The high record producer of butterfat is also a Holstein-Friesian cow that produced in one year 1,512 lb., or enough to supply 210 people for one year at the 1954 rate of butter consumption. These

outstanding individuals illustrate the miraculous ability of the udder of the cow to manufacture milk and indicate as well the possibilities that lie ahead for increasing milk production of the average cattle population.

Dairy Cattle Improvement

Organized efforts by federal and state research and educational agencies, breed societies, and other groups have been pursued for many years to assist the farmer in improving his dairy cattle. As early as Bakewell's time, records of performance and progeny testing were the tools used to measure progress. At first the tools were crude, and animal breeding was largely an art rather than a science. Early in the 19th century the gallon measure and later the milk scale were the principal means of measuring the amount of milk a cow produced. The yield of butter was also used as a yardstick of productivity. In 1890 the immortal Babcock of Wisconsin developed the quick, easy Babcock test for butterfat in milk. This test in combination with the scales for weighing the yield of milk has provided practical and effective means for measuring the producing ability of cows.

Progeny Testing Breeding Stock

Measuring the productivity of progeny of breeding animals offers possibilities for selection of animals of superior transmitting ability for breeding purposes to produce better animals in the next generation. From the earliest times selection has been an important tool used by farmers and breeders in their efforts to develop superior animals. But to utilize selection intelligently, performance and progeny testing are needed to provide the information on animals on which to base selection.

Even though the sire and dam may contribute equally to the inheritance of their offspring, emphasis is placed on the selection of the sire to advance improvement most rapidly because he has an opportunity to contribute his influence to many more animals in a herd in a given time than does a cow. Thus the use of sires of known superior transmitting ability is most valuable for improving the producing ability of cows in farmers' herds.

Effective methods are available for farmers to use in testing their cows for production in order to identify and select for mating purposes those animals best able to pass on to their offspring qualities that make for high efficient milk production. Farmers and breeders are doing their best to utilize the best available germ plasma to produce each succeeding generation of animals.

Use of Artificial Insemination

Another important development that has added to the miracle of the dairy cow is the introduction and use of artificial insemination. Long ago an Italian scientist demonstrated that spermatozoa from the male could be artificially introduced into the female reproductive tract, resulting in the fertilization of the egg and the formation of an embryo. The technique was adapted to use in cattle first in Europe and Russia and later, beginning in 1939, in the United States. Artificial breeding has been taken up by dairy farmers at a rapidly increasing rate. Presently about 20% of the dairy cattle of breeding age are serviced by artificial means. Service is available to any dairy farmer in the United States.

Artificial breeding offers a means of spreading the influence of superior sires over a much larger cow population than is possible by natural breeding. The average sire in breeding studs provides service for more than 2,000 cows compared with only about 50-70 when the sires are used in an individual farmer's herd.

Recently scientists have found a way of conditioning semen, the male germinal fluid, so that it can be frozen and held in frozen storage for a considerable period of time without materially impairing the viability of the sperm. This remarkable achievement offers a means of greatly extending the services of outstanding bulls. It is estimated that by using this technique the semen produced by selected sires can service as many as 100,000 cows per year.

Thus, it is evident that man has made good progress in developing scientific information and techniques during the past two centuries and has effectively applied what he has learned to develop attributes in the dairy cow which have enabled her to secrete increasing amounts of milk with each succeeding generation of animals. Much progress has been made, but still more is needed to continue the development of the special qualities of the dairy cow to continue to provide the needs of a rapidly increasing human population.

Improvements in Feeding Dairy Cattle

The amount of milk that a dairy cow will produce depends on the inheritance which she possesses for this quality and on the opportunity which she has to produce to the limit of her inherited ability.

Of the opportunity factors, feeding probably is the most important. The nutrients utilized by the cow in maintaining her body processes and for secreting milk must come from the feed she eats. About half the nutrients required by the average cow during a year are used for maintaining body processes and the other half for milk secretion. With cows producing more than the average, a larger percentage of the total nutrient requirements is used for milk secretion.

In the early periods following domestication the cow obtained her feed supply from the natural vegetation, mainly grasses of various kinds. With the developing of the milk secretion function, the cow's feed requirements increased and farmers began providing more ade-

quate feed supplies. This was done by improving natural grasslands and using them for pasturage and by providing supplemental sources of feed in the form of hay, silage, grains, and grain by-products. These feeds were especially needed during the cold, nongrowing seasons when grazing was scarce or not available. Thus, as man began to improve cattle for milk-producing purposes, he also began improving and providing more adequate feed supplies.

Agricultural scientists have continually studied feed materials to establish their nutritive value. Likewise, they began analyzing milk and the body tissues of animals. From such information came knowledge of the requirements of animals for protein, energy, minerals, and vitamins. This led to the establishment of standards of nutrient requirements for animals for maintenance, fattening, milk secretion, etc., which are used as guides for proper feeding of animals.

The problem of providing an adequate, complete, efficient, and low-cost ration for his dairy cows is one of the most important problems confronting the dairy farmer. Usually most of the basic ingredients used come from the home farm. The cropping system on dairy farms, therefore, is planned around providing the necessary feed supplies throughout the year. More than 70% of the ration of the average dairy cow in the United States comes from grassland forages. An estimate of the amount of land required to grow the feed for cows of different sizes and productive abilities is shown in Table 3. Frequently, not all of the forage and grain needed to supply the necessary feed for the dairy herd can be provided from the home farm. Supplemental feed is purchased as grains, grain and seed by-products, and commercial formulated grain mixtures. A large and well developed commercial feed industry provides a ready source of high class feeds and feed mixtures for dairy cattle and other livestock.

Tremendous quantities of feed are required to nourish the national dairy herds. In Table 4 are summarized the amounts of feed units from feeds of different classes used to feed the nation's dairy cattle, including replacement young stock, in 1949-50. The percentage of the feed supply consumed by all livestock in the United States and that part used by dairy cattle is given in Figure 8.

Advances in Control and Elimination of Diseases

Dairy cows, like other animals and man, are subject to the hazards of numerous diseases and parasites. Veterinarians and research workers for years have been developing information and programs that have enabled farmers to keep under control maladies caused by diseases and parasites or to eliminate them from their farms and localities. Some diseases have been eliminated almost completely as a result of area and nationwide eradication programs. The almost complete eradication of tick fever among cattle in the southern United States and of tuberculosis in the entire country has been achieved by such programs. Bang's disease, another serious malady among cattle, is presently yielding to area eradication programs. Numerous other diseases exist that can wreck havoc in dairy herds, and it is only through realizing the

TABLE 3

Land requirements to provide the feed supply for a dairy cow for 1 year[a]

Weight of cow	Milk yield in FCM	Forage required		Grain required	Land acreage required for:					
					Hay					
		Hay	Corn or sorghum silage		Alfalfa	Clover and timothy	Corn or sorghum for silage	Corn	Oats	Pasture
	(lb.)	*(tons)*	*(tons)*	*(lb.)*	*(acres)*	*(acres)*	*(acres)*	*(acres)*	*(acres)*	*(acres)*
900	5,000	1.5	2.7	410	0.75	1.15	0.34	0.09	0.11	2
900	7,500	1.5	2.7	1,470	0.75	1.15	0.34	0.33	0.38	2
900	10,000	1.5	2.7	2,530	0.75	1.15	0.34	0.56	0.66	2
1,200	5,000	2.0	3.6	400	1.00	1.54	0.45	0.09	0.10	2
1,200	7,500	2.0	3.6	1,580	1.00	1.54	0.45	0.35	0.41	2
1,200	10,000	2.0	3.6	2,760	1.00	1.54	0.45	0.62	0.72	2

[a] Science and Farming, Yearbook of Agriculture, p. 152. USDA, Washington, D. C., 1947.

TABLE 4

Estimate of feed consumed by the national dairy herds, by classes of feed, year beginning October 1, 1949[a]

Class of feed	Feed units consumed
	(1,000 tons)
Pasture	31,688
Harvested forages	29,640
Concentrates	23,968
All feeds	85,296

[a] Adapted from Table 34, USDA Stat. Bull. No. 153. 1955.

danger and cooperating with the local veterinarians that the farmer can keep such diseases away from his herd. The best guard against losses from diseases is to keep the cows in a clean, healthful environment. This, together with the availability of a thoroughly competent veterinarian service in the United States, enables farmers to go forward confident that their herds

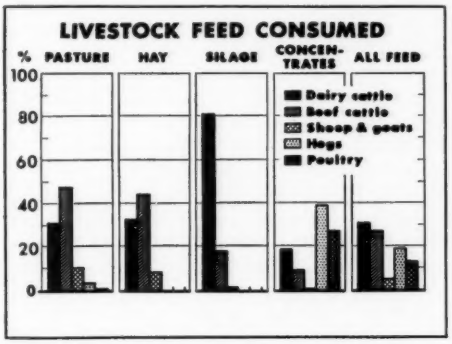

FIG. 8. Relative percentage of principal feeds consumed by different classes of livestock in the United States (feed units)—1949-50. (From USDA Stat. Bull. 153,Washington, D. C. 1955.)

can be maintained without serious loss from diseases. This service also does much to guarantee to the consuming public a safe disease-free milk supply.

Dairy Farming Yielding to Labor Efficiency

The amount of work involved in caring for the national dairy herds is tremendous. Under usual conditions cows in lactation are milked twice daily, morning and evening. Because of this and the fact that cows when not on pasture are fed at least twice daily, the job of caring for them is confining and requires a lot of time. Although the modern trend in farming is toward mechanization, caring for dairy cows does not easily lend itself to mechanization. Men have to attend cows to supervise and do the work. The mechanical milking machine, introduced in the early 1900's, has mechanized the milking operation on many dairy farms and has reduced the time required to milk cows. This is indicated in Table 5, which shows the time per year required for taking care of a dairy cow and for producing 100 lb. of milk. It is evident from these data that less time is required to milk cows by machine than by hand. Over half the milk cows in this country are milked by machine.

Advances have been made in other chore operations also. The milking parlor, together with pipe line milking machine installations and the storage of milk in bulk in cold wall tanks on farms, is being introduced. Self-feeding

TABLE 5

Man hours used per year per cow and per unit of production on American dairy farms in 1950[a]

Man hours used per head[b]			Man hours used per 100 lb. milk produced
Machine milked	Hand milked	All	
111	140	125	2.4

[a] Stat. Bull. 161, Agr. Research Serv., USDA. 1955.

[b] Includes direct labor for feeding, milking, cleaning barns, moving animals to and from pasture, general care, and disposing of animals and milk.

arrangements and mechanical handling of feed are commonplace. These modern procedures reduce the time and hard work involved in caring for cows.

Efficiency of Dairy Industry Can Be Improved

Thus we see that the dairy cows of this nation perform miracles of transforming the grasses, legumes, and seed and their by-products into food that comprises nearly one-fifth of our diet. The dairy industry, however, is not without its problems. As was seen, the consumption of milk and its products is not as high as it should be in relation to optimum nutrition of our people and in comparison with that of many other countries. Even so, there are times when consumers do not take all that is produced. One solution to this problem is increased research and education programs that will yield new facts about milk and its products as foods and that will cause increased acceptance of these foods by the people. American dairy farmers have organized a program to this end.

The average production of our dairy cow, while creditable, is not high enough to make for the greatest efficiency in production and high returns for the farmer's endeavors. A much larger research program in public research institutions is needed to provide new information in all phases of dairy farming to increase the efficiency of milk production. Additional research effort is needed to provide the basis for a continuing increase in the quality of the product of the dairy cow so that when it reaches the consumer it will be palatable, nutritious, and pleasing.

In addition to the creation of this basic knowledge, there is need for a great expansion in the education and extension activities among dairy farmers to the end that the most modern and efficient practices will be adopted on their farms as soon as possible. All of these things are needed in a modern dairy farming industry to make the miracle of the dairy cow more effective in a dynamic society.

Dairy Farming Industry Offers Many Opportunities

The size of the dairy farming industry and the importance of the product of the dairy cow to our society rank it in first order among our industries. There are many facets to the dairy farming industry and therefore many opportunities. These opportunities are rewarding and deserve the attention of young people who are deciding on a life's vocation. The industry needs the services of industrious, well-trained young people. There are many avenues of interest in the dairy farming industry. First of all, there is the need for young people to take up dairy farming. The future industry must be built on young people on dairy farms, and while such occupation is confining it also is rewarding not only in material ways but from the satisfaction of working with the noble beast, the dairy cow.

Opportunities also exist as herdsmen for other farmers and breeders, as field representatives of plants, farmer associations, industrial organizations, feed companies, and sanitary control organizations. Many opportunities exist in the extension-educational aspects of dairy farming, including vocational agricultural teaching and as representatives of breed associations, artificial breeding associations, dairy herd improvement associations, etc. There is a great need for young people to take up their life's work in the field of dairy research and teaching. These and many other related opportunities await the young person who finds an interest in the dairy cow. Those who meet these opportunities with sound training and with industry to challenge the work ahead can find a rewarding experience in advancing the miraculous achievements of the dairy cow.

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ABSTRACTS OF LITERATURE

W. O. Nelson, Abstract Editor

BUTTER

448. Fria fettsyror i smör och deras inverkan pa fetthaltsbestämningen. (Free Fatty Acids in Butter and Their Influence on the Determination of Butterfat). STIG WILLART, Alnarp, Sweden. Svenska Mejeritidningen, **48**, 14: 1. 1956.

The constantly lower fat tests on butter obtained by the Roese-Gottlieb method as compared to the results obtained by the Schmid-Bondzynski-Ratzlaff method were shown to be due to the fatty acids not being extracted by the R-G method. A quantitative determination of the free fatty acids in several lots of butter revealed that the differences between the two methods corresponded to the amounts of free fatty acids present in the butter.

T. Kristoffersen

449. Yield and properties of fractions separated from butterfat by cold crystallization. K. G. WECKEL and J. A. STEIN, Dept. of Dairy & Food Ind., Univ. of Wis., Madison. Milk Prod. J., **47**, 5: 22. 1956.

Butterfat was separated into 4 fractions by means of cold fractional crystallization. The yield of the various fractions was affected by the season, and by the type of ration which the cows received. Butterfat and the fractions separated from it differed in consisteney and in melting characteristies. The degree of unsaturation of the fat in the fractions also varied.

J. J. Janzen

CHEESE

450. Fettspjälkning i Svensk hard löpeost (Fat Hydrolysis in Swedish hard rennet cheese) G. SJÖSTRÖM and S. WILLART, Alnarp, Sweden. Svenska Mejeritidningen, **46**, 18, 19: 277-287, 293-298. 1954.

Various cheeses of Swedish origin were examined for fat hydrolysis and qualitatively for fatty acids by the paper chromatography.

Caprylic, caprie, and higher fatty acids were found in all cheese containing 45% fat in the dry matter, but were not detected in cheese containing only 30% fat in the dry matter. The presence of caproic, butyric, and propionic acids varied both with regard to the type of cheese and within the type. Acetic acid, which could not be separated from lactic acid, was found in all cheeses.

The appearance of fatty acids was studied in freshly made Herrgårdsost, Prästost, and Cheddar cheese. Acetic and lactic acids were present in all types at the one day examination. Butyric acid was found in Herrgårdsost and Prästost after 60-70 d., but not in Cheddar cheese even after 110 d. Caproic, caprylic, and caprie acids appeared after 3-5 wk. in Prästost and Cheddar cheese. Caprylic and caprie acids appeared at about the same time in Herrgårdsost whereas caproic acid never was demonstrated in this cheese. Fatty acids higher than caprie acid appeared in all three types after about 3 mo. of curing. Flavor scores of the cheese were not correlated with the amount or presence or absence of specific free fatty acids. However, fatty acids were considered important flavor constituents of hard rennet cheese.

T. Kristoffersen

451. Fettspjälkning i dessertost och emmentalerost. (Fat Hydrolysis in Dessert Cheese and Emmentaler Cheese). S. WILLART, Alnarp, Sweden. Svenska Mejeritidningen, **47**, 52: 1. 1955.

Fat hydrolysis was studied in Camembert, Port Salut, Stilton, Blue cheese, and Emmentaler using quantitative chromatographie methods.

Camembert and Port Salut exhibited similar patterns. Fresh cheese contained only acetic acid. The surface of ripened cheese contained considerable amounts of C_5 and higher fatty acids in addition to some butyric acid. The center of both ripened Camembert and Port Salut contained but little of the higher fatty acids and no butyric acid. Ripened Stilton and Blue cheese were high in the C_5 and higher fatty acids as well as in butyric acid.

The surface and interior of Emmentaler of Danish, Swedish, Finnish, and Swiss origin were similar in fatty acid contents. The surface usually contained 3-4 times as much of C_5 and higher and butyric acids as the interior.

T. Kristoffersen

452. An analysis of cottage cheese factors in relation to consumer demand. L. G. Harmon, G. M. Trout, and M. D. Bonner, Mich. State Univ., East Lansing. S. Dairy Prod. J., **59**, 2: 44. 1956.

Eighty-three samples of commercial cottage cheese ranged from 1.69 to 7.84% (av. 4.22%) fat. Total solids ranged from 14.5 to 27.1% (av. 21.41%). The need for more accurate weight control of packages was indicated. The shelf-life ranged from 6 to 23 d., at 42° F. The shelf-life was 51% longer at 42° F. than at 50° F. Differences of as much as 14° F. were found between the upper and lower display levels in cabinets. Surface slime was the most common defect. This defect, unclean, putrid, and bitter flavors occurred more rapidly and/or more frequently above pH 5.0. Musty, yeasty, and sour flavors were more frequent at low pH. Fruity flavors showed no pH reference. All samples collected ranged from pH 4.50 to 5.28.

F. W. Bennett

CONDENSED AND DRIED MILKS; BY-PRODUCTS

453. Casein compounds. H. K. Salzberg (assignor to The Borden Co.). U. S. Patent 2,748,009. 4 claims. May 29, 1956. Offic. Gaz. U. S. Pat. Office, **706**, 5: 1191. 1956.

A casein compound is described which is insoluble in water and alcohol, but soluble in mixtures of the two. The compound is prepared from a combination of casein and alkyl imidazoline nuclei.

R. Whitaker

454. Dairy-Pack orange juice and how Kraft produces it. C. W. Kaufman, Kraft Foods Co., Chicago. Food Eng., **28**, 6: 60. 1956.

After careful analyses of "dairy-pack" orange juice operations, Kraft Foods Co. has entered the field on a test market basis. The program is built around orange juice concentrate with multiple reconstitution stations a few hours distance from local markets. The juice is stabilized by heat, concentrated, bulk packaged in polyethylene-lined fiber drums, quickly frozen at –10° F. and stored until used. The concentrate is transported to the reconstitution stations, blended with water to its original strength, packaged in dairy type cartons and handled through refrigerated distribution.

The use of the concentrate has the following advantages: 1. The concentrate can be packed at a time when juice quality is highest. 2. It provides a uniform quality product in all areas throughout the year. 3. It permits storage and distribution to reconstituting stations in a form that does not readily deteriorate. Disadvantages include the high investment necessary to purchase a year's supply in a short period and the higher initial cost of the concentrate. Since there is yet no federal standard of identity for orange juice, problems of uniformity in labeling and product quality definitions exist.

T. J. Claydon

DAIRY BACTERIOLOGY

455. Characteristics of organisms isolated from the rumen of cows fed high and low roughage rations. H. E. Bauman and E. M. Foster. J. Bacteriol., **71**, 333. 1956.

Trypticase-soy semi-solid medium was used. Most samples showed growth in the 10^{-10} dilution of solid material obtained from squeezing rumen contents through cheese cloth. Gram-positive, pleomorphic, anaerobic rods resembling *Lactobacillus bifidus* were the most numerous organisms when the cows were on a high-roughage ration. These organisms fermented glucose almost entirely to acetic and lactic acids in a molar ratio of 2:1. Only traces of CO_2 and acetoin were produced.

When a high-grain ration was fed, the organisms found in the largest numbers were gram positive cocci similar to those of the genus *Pediococcus*. They occurred mainly in pairs and tetrads. Glucose was converted primarily to lactic and acetic acids in a molar ratio of 10:1, with only minor amounts of acetoin and CO_2. Cellulose was not digested by any of the isolates. Starch and a variety of simple sugars were fermented to acids.

F. E. Nelson

456. The nature of some growth stimulatory substances for Lactobacillus delbrueckii. M. Ikawa and J. S. O'Barr. J. Bacteriol., **71**, 401. 1956.

Addition of crude natural materials reduces the time required for heavy growth from small inocula in a defined medium. The lag phase is reduced but the rate of growth is not increased materially. Two types of material (a) degradation products of ribonucleic acid and (b) peptides present in enzymatic digests of proteins, were most actively stimulatory. Uridylic and cytidylic acids were the most active pure compounds tested in promoting rapid growth.

F. E. Nelson

457. Capillary tube method for counting viable bacteria (Note). T. Yanagita. J. Bacteriol., **70**, 381. 1956.

The bacterial suspension is diluted with saline until each ml. contains 1,000 to 10,000 viable cells. This suspension (0.5 ml.) is mixed thoroughly with 4.5 ml. of melted nutrient agar (nutrient broth + 0.5% $NaNO_3$ and 0.8% agar). The inoculated agar then is sucked into 3 capillaries, each of which is marked to indicate a volume of 0.5 ml. After incubation at 37° C. for 24 hr., the colonies are counted using a special counter with dark-field illumination. Details of the capillary dimensions and the counting device are presented.

F. E. Nelson

458. Relationships of coagulase and urease in Micrococcus pyogenes (Note). M. H. Fusillo and W. J. Jaffurs. J. Bacteriol., **70**, 481. 1955.

Cultures grown in trypticase soy broth were tested for coagulase activity on rabbit plasma.

Thirty-five cultures were coagulase positive and urease negative, 42 were coagulase negative and urease positive, 8 were positive to both tests and 6 were negative to both. When 36 organisms which were coagulase negative when grown in tryptiease soy broth were grown in an arginine yeast medium, 23 produced plasma clot or evidence of fibrin. The authors suggest that coagulase may be an adaptive enzyme related to an arginase. The relationship between virulence and coagulase production may be less direct than some have assumed. F. E. Nelson

459. The effect of certain sporulation conditions on the thermal death rate of Bacillus coagulans var. thermoacidurans. H. M. El-Bisi and Z. J. Ordal. J. Bacteriol., **71**, 1. 1956.

Neither type of medium used for production of spores nor the pH of the medium had a statistically significant effect on the death rate of spores produced. A 1% phosphate concentration in the growth medium reduced the thermal resistance markedly, in comparison to a 0.5% concentration. The markedly better pH control with the higher phosphate concentration could explain these results, although the authors use an explanation based upon Ca binding by phosphate. F. E. Nelson

460. The effect of sporulation temperature on the thermal resistance of Bacillus coagulans var. thermoacidurans. H. M. El-Bisi and Z. J. Ordal. J. Bacteriol., **71**, 10. 1956.

When spore preparations were heated at 93 and 96° C., those spores from cultures grown at 45° C. had a significantly greater resistance than did spores from cultures grown at 30° C. Possible causes for deviations from a straight-line relationship between logarithm of number of survivors and time of exposure to the lethal heat level were discussed. F. E. Nelson

461. The characteristics of lactate-fermenting sporeforming anaerobes from silage. M. P. Bryant and L. A. Burkey. J. Bacteriol., **71**, 43. 1956.

Seventy-four strains of *Clostridium tyrobutyricum* were isolated from orchard grass and alfalfa silages. These were differentiated from *Clostridium butyricum* by their inability to ferment a number of carbohydrates fermented by the latter organism. *C. tyrobutyricum* did not form curd and gas in milk, while *C. butyricum* did. Both organisms fermented lactate in the presence of acetate, while *C. pasteurianum* did not. Sixty of the isolated strains of *C. tyrobutyricum* fermented mannitol and a few fermented additional carbohydrates; the previously published descriptions of this species by van Beynum and Pette did not indicate fermentation of carbohydrates other than glucose and fructose. F. E. Nelson

462. Variation among the heterofermentative lactic acid bacteria. C. S. Pederson and M. H. Albury. J. Bacteriol., **70**, 702. 1955.

Failure of sucrose fermenting strains of the genus *Leuconostoc* to produce dextrans and failure of both leuconostoc and lactobacilli cultures to produce normal amount of acid may occur under unusual conditions such as low temperatures or high salt concentrations. Serial transfer in favorable media, such as in acid media containing either tomato or orange juice, stimulates many strains to react in a manner more typical of the species. F. E. Nelson

463. Tellurite-glycine agar: A selective plating medium for the quantitative detection of coagulase-positive staphylococci. E. Zebovitz, J. B. Evans, and C. F. Niven, Jr. J. Bacteriol., **70**, 686. 1955.

The medium contains 1.0% Tryptone, 0.5% yeast extract, 0.5% mannitol, 0.5% K_2HPO_4, 0.5% LiCl, 1.0% glycine, 2.0% agar and 0.02% potassium tellurite (added aseptically after sterilization and cooling to 50° C.). The medium is adjusted to pH 7.2 before autoclaving. The plates contain 20 ml. of agar and are surface inoculated, using an 0.1-ml. aliquot. Incubation is at 37° C. for 24 hr. The medium should be fresh each time plates are poured. However, poured plates may be stored as long as 30 d. in a sealed container under refrigeration. Some lots of potassium tellurite are superior to others. Black colonies are produced by coagulase-positive strains. Some strains of coagulase-positive organisms are partially inhibited by this medium and some coagulase-negative strains may develop. Using this medium for plating, coagulase-positive staphylococci were of relatively rare occurrence in air, dust, soil, food products, the skin (other than finger tips), throat and feces. The organisms were quite common in the nose and on the fingers of people who harbor them in their nose. F. E. Nelson

464. Comparison of two media proposed for the isolation of bacteria from the rumen. K. W. King and P. H. Smith. J. Bacteriol., **70**, 726. 1955.

An inorganic salts-rumen fluid-sugar-cellulose medium was compared with a highly organic medium. The former medium gave higher total counts, higher counts of cellulolytic organisms, greater diversity of morphology among the cellulolytic organism types, and better ability to support growth of cellulolytic isolates from the other medium. F. E. Nelson

465. The metabolism of labeled glucose by the propionic acid bacteria. H. G. Wood, R. Stjernholm, and F. W. Leaver. J. Bacteriol., **70**, 510. 1955.

Propionibacterium arabinosum and *P. shermanii* may have in part different mechanisms of glucose fermentation. The proposal is made that cleavage of the Embden-Meyerhof type may be associated with a simultaneous second type of cleavage which is not yet identified. The second pathway is postulated to account for the high

yield of CO_2 from C-1 of glucose and the conversion of the 3- and 4- carbons of glucose to acetate and the 2- and 3-carbons of propionate and succinate. Details of the experimental procedures and recoveries of the various labeled products are given. F. E. Nelson

466. Product labeling of glucose-1-C^{14} fermentation by homofermentative and heterofermentative lactic acid bacteria. M. GIBBS, J. T. SOKATCH, and I. C. GUNSALUS. J. Bacteriol., **70**, 572. 1955.

The heterofermentative strains (*Leuconostoc mesenteroides, Leuconostoc dextranicum, Lactobacillus fermenti, Lactobacillus pentoaceticus,* and *Lactobacillus* sp.) ferment glucose by the hexosemonophosphate pathway. *Lactobacillus pentosus* and *Streptococcus faecalis* ferment glucose-1-C^{14} to methyl-labeled lactate, characteristic of an Embden-Meyerhof pathway.

F. E. Nelson

467. The pathways of glucose dissimilation by Microbacterium lacticum. P. J. VANDEMARK and W. A. WOOD. J. Bacteriol., **71**, 385. 1956.

Evidence of both Embden-Meyerhof and hexosemonophosphate pathways for hexose dissimilation was obtained. F. E. Nelson

DAIRY CHEMISTRY

468. Indicator for titration of calcium in presence of magnesium using disodium dihydrogen ethylenediamine tetraacetate. H. DIEHL and J. L. ELLINGBOE, Dept. of Chem., Iowa State Coll., Ames. Analyt. Chem., **28**, 5: 882. 1956.

In the analysis of Ca and Mg in limestone or water, one is usually determined separately and the other calculated by difference. A new indicator, designated calcein, has been prepared for the titration of Ca in the presence of Mg with disodium dihydrogen ethylenediamine tetraacetate. No preliminary treatment is necessary beyond dissolving and adjusting the sample to pH 12. A sharper endpoint is ibtained with Ca than with murexide and larger quantities of Mg may be present without impairing the endpoint.

B. H. Webb

469. New indicator for titration of calcium with (ethylenedinitrilo) tetraacetate. J. PATTON and W. REEDER, Campbell Taggart Research Corp., Dallas, Texas. Analyt. Chem., **28** 6: 1026. 1956.

A new indicator, 2-hydroxy-1-(2-hydroxy-4-sulfo-1-naphthylazo)-3-naphthoic acid, has been synthesized which makes possible a direct titration of Ca in the presence of Mg. The indicator produces a sharp, stable color change from wine red to pure blue. Ca and Mg separations are not necessary. Titration procedures for the determination of Ca and Mg in water, limestone, salt, and boiler scale are described.

B. H. Webb

470. Sedimentation of Milk Proteins as a Function of Certain Ions. S. J. BISHOV and J. H. MITCHELL, JR., Q.M. Food and Container Inst. for Armed Forces, Chicago, Illinois. Food Technol., **10**, 7: 312. 1956.

Changes in the nature of milk colloids due to alterations in mineral composition, and denaturation of proteins by heat were studied by examining the sediment fraction obtained by centrifugation of milk with a Sharples Supercentrifuge. Ion exchange processes, sequestering agents, and electrolytes were used to remove or alter the mineral constituents in the milk studied.

Less sediment was obtained from fresh milk and from milk heated to 170° F. for 30 min. than from reconstituted spray-dried milk. When Ca was decreased 30% prior to drying, sediments comparable to those from fresh milk were obtained. Ca and Mg were the only cations in milk that formed insoluble complexes with the proteins. Addition of Ca over normal levels increased the amount of sediment and the optical density of milk, but removal of Ca by resinous ion exchange, or the addition of a sequestering agent, reversed this effect. The addition of sodium citrate up to the 1% level decreased the amount of sediment and optical density of milk more than 50%. The addition of disodium phosphate to the same level had no appreciable effect on sediment or opteial density.

E. R. Garrison

471. Production of lactobionic acid and its δ-lactone. E. R. MAGARIELLO (assignor to National Dairy Research Laboratories, Inc.). U. S. Patent 2,746,916. 7 claims. May 22, 1956. Offic. Gaz. U. S. Pat. Office, **706**, 4: 904. 1956.

An electrolytic process for producing lactobionic acid from lactose, using iodine or bromine as a catalyst at a pH of 5.2 or above. The acid is recovered by passage through strong acid and weak base ion exchange resins. Spray drying of the acid at a suitably high temperature yields the δ-lactone. R. Whitaker

472. Production of casein-lactalbumin coprecipitate. H. W. HOWARD, H. K. SALZBERG (assignors to The Borden Co.). U. S. Patent 2,750,374. 2 claims. June 12, 1956. Offic. Gaz. U. S. Pat. Office, **707**, 2: 524. 1956.

The lactalbumin of milk is coagulated with the casein by adding a cationic surface active agent such as tertiary amine parts and quaternary ammonium parts. The pH is maintained at 5.82 or higher. The temperature employed is below that which causes lactalbumin to coagulate. R. Whitaker

473. Conversion of lactose to glucose, galactose and other sugars in the presence of lactase activators. E. G. STIMPSON and O. E. STAMBERG (assignors to National Dairy Research Labs., Inc.) U. S. Patent 2,748,242. 18

claims. June 5, 1956. Offic. Gaz. U. S. Pat. Office, **707**, 1: 227. 1956.

The conversion of lactose to glucose and galactose by lactase is improved by the addition of an activator. The activators contain an active sulfur atom and include such radicals as sulfide, hydrosulfide, sulfite, bisulfite, metabisulfite, hyposulfite, thiosulfate, mercapto, and sulfur dioxide. R. Whitaker

474. New solids test proves accurate. R. R. ROBINSON, W. S. ARBUCKLE, and E. A. CORBIN, Univ. of Md., College Park. Milk Plant Monthly, **45**, 6: 26. 1956.

The U. S. D. A. lactometer method for S. N. F. yielded results on mixed herd milk which averaged within 0.1% of the values obtained gravimetrically. The range in variation for mixed herd milk was –0.16 to +0.28%. The deviation for milk from 60 individual cows when computed for S. N. F. ranged from –0.30 to +0.27% as compared to a mean deviation of 0.115% S. N. F. obtained by the gravimetric method. These results indicate that the U. S. D. A. lactometer method offers greater accuracy than previously proposed lactometer methods.

C. J. Babcock

DAIRY ENGINEERING

475. Portion control for dispensing freezer. H. F. SWENSON. U. S. Patent 2,746,260. 5 claims. May 22, 1956. Offic. Gaz. U. S. Pat. Office, **706**, 4: 743. 1956.

An electrical system is described which delivers uniform individual size portions of soft serve frozen desserts from a freezer. Portions are controlled by a timer which opens the delivery valve for a specified length of time when the freezer operator pushes a button.

R. Whitaker

476. Machine for charging and closing paper containers. J. F. EARP and C. M. CLEMENS (assignors to Ex-Cell-O Corp.). U. S. Patent 2,750,721. 12 claims. June 19, 1956. Offic. Gaz. U. S. Pat. Office, **707**, 3: 621. 1956.

A machine is described which fills preformed paper cartons with milk or other liquids.

R. Whitaker

DAIRY PLANT MANAGEMENT AND ECONOMICS

477. Milk distribution costs. G. W. STARR, Indiana Univ. S. Dairy Prod. J., **59**, 2: 52. 1956.

An analysis of 402 milk distributor reports for 1954 from the D. C. and all states except Rhode Island and Utah revealed an av. price paid of $5.32/cwt, av. test 3.83% fat and av. price of home delivered milk 22.94¢/qt at the end of the calendar year. The distribution of the national av. trade sales $1.00 with the ranges of regional av. within the 13 Milk Industry Foundation regions in parentheses were material costs (raw product) $0.4715 (.3826-5834), purchased transportation .0085 (.0003-.0220), other material cost .0895 (.0454-.2254), salaries, wages, and commissions .2119 (.1434-.2590), administrative officers' salaries .0097 (.0046-.0191), containers .0552 (.0374-.0692), plant, delivery, and office supplies .0553 (.0403-.0646), taxes and licenses .0306 (.0163-.0485), insurance .0052 (.0042-.0096), advertising .0107 (.0051-.0164), depreciation .0151 (.0077-.0232), other expense .0140 (.0072-.0262), total cost .9772 (.9579-.9934), and operating profit .0228 (.0066-.0421).

F. W. Bennett

478. Dispensing container. C. R. ALDEN (assignor to Ex-Cell-O Corp.). U. S. Patent 2,751,137. 6 claims. June 19, 1956. Offic. Gaz. U. S. Pat. Office, **707**, 3: 731. 1956.

A method of folding the top of a Pure-Pak type of paper milk bottle to permit the formation of a pouring spout when unfolded.

R. Whitaker

479. Liquid dispensing devices. F. L. BRYANT (assignor to Dairymat Corp.). U. S. Patent 2,752,068. 5 claims. June 26, 1956. Offic. Gaz. U. S. Pat. Office, **707**, 4: 984. 1956.

A container is described for holding milk or other liquid food products. It is equipped with a sanitary outlet at the bottom for use in a dispensing cabinet. R. Whitaker

480. Paper containers. E. A. MISCH. U. S. Patent 2,750,096. 2 claims. June 12, 1956. Offic. Gaz. U. S. Pat. Office, **707**, 2: 460. 1956.

A paper milk carton with a gable shaped top is described which has a pouring spout outlet exposed by removing a tear strip and also an elongated slit covered with a transparent film for viewing the contents of the container.

R. Whitaker

481. Dispensing container with extensible pouring spout. C. R. ALDEN (assignor to Ex-Cell-O Corp.) U. S. Patent 2,750,095. 1 claim. June 12, 1956. Offic. Gaz. U. S. Pat.. Office, **707**, 2: 460. 1956.

The top gable of a Pure-Pak type paper milk carton is folded in such a way that it forms a pouring spout when unfolded. R. Whitaker

482. Milk bottle tap. E. S. MANNING, SR. U. S. Patent 2,751,119. 4 claims. June 19, 1956. Offic. Gaz. U. S. Pat. Office, **707**, 3: 726. 1956.

A tube with a pointed end is pushed into the side of a paper milk bottle to permit withdrawal of the milk or cream. R. Whitaker

FEEDS AND FEEDING

483. Feed supplements for ruminants. P. C. ANDERSON and F. N. RAWLINGS (assignor to Feed Service Corp.). U. S. Patent 2,748,001. 2 claims. May 29, 1956. Offic. Gaz. U. S. Pat. Office, **706**, 5: 1189. 1956.

A feed supplement for ruminants composed of molasses, urea, and phosphoric acid. This mixture is designed to provide essential nutrients for the rumen micro-organisms.

R. Whitaker

GENETICS AND BREEDING

484. Evidence of the same dwarf gene in Hereford, Aberdeen-Angus, and certain other breeds of cattle. P. W. Gregory and F. D. Carroll, Univ. of Calif., Davis. J. Heredity, **47**, 3: 107. 1956.

Eight dwarf cattle found in an F_1 population of registered Aberdeen-Angus × high grade Herefords were phenotypically similar to the dwarfs that segregate within each of the parental breeds and also within the Shorthorn and Holstein-Friesian breeds as far as could be ascertained from the morphological characteristics used in the diagnosis. Eleven body measurements of two of the crossbred dwarf heifers taken at two years of age were presented in comparison with 52 normal Hereford heifers of the same age. No reason to suspect the presence of hybrid vigor in the crossbred dwarfs was found. In the absence of matings made to produce an F_2 population to study the specific relationships involved, it was assumed that the same recessive gene causing dwarfism was common to both breeds. The biological and practical significance of certain evolutionary considerations are presented. L. O. Gilmore

HERD MANAGEMENT

485. Farm milk testing. M. W. Jensen, Office of Weights and Measures, National Bureau of Standards. Milk Prod. J., **47**, 5: 17. 1956.

The National Conference on Weights and Measures has defined the farm milk tank as follows:

> "A unit for measuring milk or other fluid dairy product, comprising a combination of:
>
> (1) a stationary or portable tank, whether or not equipped with means of cooling its contents.
>
> (2) means for reading the level of liquid in the tanks, such as a removable gage rod or surface gage.
>
> (3) a chart for converting level-of-liquid reading to gallons, . . ."

This code aplies to farm milk tanks only when used or to be used under an express contract between a producer and purchaser and only on the premises of a single producer, for the commercial measurement of milk or other fluid dairy products.

The author discusses the subject of farm milk tank testing under the following headings: development of model weights and measures codes, weights and measures consideration, measurement of contents, operations for accuracy, scope of weights and measures control, inspection, specification and regulations, tank levels, legal tolerances and supervision over use of commercial devices. J. J. Janzen

486. Do's and don'ts in making the switch. C. W. Livak, Penn Dairies, York, Pa., Milk Plant Monthly, **45**, 5: 30A. 1956.

Statewide regulation of bulk pick-up is becoming more prevalent. The tank requirements of the Pa. State Control Commission and the rules of the State Bureau of Standard Weights and Measures are given. C. J. Babcock

487. Vacuum container milking system and apparatus therefor. G. R. Duncan (assignor to Zero Manufacturing Co.). U. S. Patent Reissue 24,162. 18 claims. June 5, 1956. Offic. Gaz. U. S. Pat. Office, **707**, 1: 11. 1956.

Essentially the same as U. S. Patent 2,702,-019 (see J. Dairy Science Literature Abstrs. #264, Vol. 38, No. 4, A43). R. Whitaker

488. Teat cup support assembly. C. A. Thomas (assignor to Babson Bros. Co.) U. S. Patent 2,747,544. 9 claims. May 29, 1956. Offic. Gaz. U. S. Pat. Office, **706**, 5: 1074. 1956.

A pivotally mounted arm, attached to the framework of a milking parlor stall, provides support for the teat cup assembly of a milking machine. A second arm, constructed of spring material, applies a downward pull to the teats during milking. R. Whitaker

ICE CREAM

489. The injection method for fruit ice cream. W. A. Krienke, Fla. Agr. Expt. Sta., Gainesville. S. Dairy Prod. J., **58**, 6: 54. 1955.

Maximum fruit flavor in ice cream may be obtained by injecting the unheated fruit juice or pulp in a sweetened pectinized mixture into the ice cream as it leaves the freezer. An av. recommended composition of the injection material is pectin (150 grade) 0.6-1.2%, sucrose 28%, corn syrup 25%, water 8%, and fruit 37.8-38.4%. Sugar equal in weight to the water and pectin are added to the water, well-blended, heated to 180° F. and the other ingredients added in order without additional heating but with continuous agitation. The pH should be adjusted if necessary with citric acid to as low or lower than that of the fruit. Prolonged storage of the injection mixture should be at 0° F. or lower. Injection into the ice cream at the rate of 20% by weight at a temperature no higher than that of the ice cream is recommended.

F. W. Bennett

490. Packaging and dispensing of soft plastic foods. L. Peters. U. S. Patent 2,750,294. 8 claims. June 12, 1956. Offic. Gaz. U. S. Pat. Office, **707**, 2: 509. 1956.

An individual serving of ice cream or other dessert consisting of a thin, flexible, shaped film

stretched across a cylindrical cardboard support. The portion is easily discharged by pressing on the flexible film and ejecting the product.
R. Whitaker

491. Multiple outlet ice cream dispenser. S. OVERLAND. U. S. Patent 2,750,083. 3 claims. June 12, 1956. Offic. Gaz. U. S. Pat. Office, **707**, 2: 456. 1956.

A device for dividing a stream of ice cream from a continuous freezer into a number of smaller streams all of which are continuous and of equal uniform flow. R. Whitaker

492. Sandwich making machine. S. F. ANDERSON (assignor to S. F. Anderson and R. F. Anderson.) U. S. Patent 2,748,726. 14 claims. June 5, 1956. Offic. Gaz. U. S. Pat. Office, **707**, 1: 98. 1956.

Structural details are given for a machine for automatically and continuously making ice cream sandwiches. Soft ice cream from a continuous freezer is extruded in ribbon form between two streams of wafers. R. Whitaker

493. Flavor injection valve for ice cream. E. C. LEHNER and J. A. BRENDLE (assignors to Swift & Co.). U. S. Patent 2,748,724. 3 claims. June 5, 1956. Offic. Gaz. U. S. Pat. Office, **707**, 1: 98. 1956.

A device for injecting flavored syrups into a stream of ice cream leaving a continuous freezer. Provision is made to easily adjust the ratio of syrups to ice cream. R. Whitaker

494. Process of making frozen confections. C. O. LUND. U. S. Patent 2,747,525. 3 claims. May 29, 1956. Offic. Gaz. U. S. Pat. Office, **706**, 5: 1069. 1956.

Individual portions of ice cream or other frozen confection are frozen in molds in a brine tank. The mold is filled and held in the brine until a layer or shell is frozen adjacent to the mold wall. The unfrozen portion is removed and replaced by a mix of another flavor. The mold is returned to the brine tank and a layer of the second flavor is allowed to freeze. In similar manner, the core is filled with a third flavor. A stick is inserted in the third flavor. R. Whitaker

495. Dispensing freezer. H. F. SWENSON, A. A. BAUDAT, and H. RYDER (assignors to Sweden Freezer Manufacturing Co.). U. S. Patent 2,746,730. 15 claims. May 22, 1956. Offic. Gaz. U. S. Pat. Office, **706**, 4: 863. 1956.

Details are given for a horizontal ice cream freezer with a spiral type dasher blade.
R. Whitaker

496. Ice cream mold. F. BAXTER. U. S. Patent 2,746,402. 4 claims. May 22, 1956. Offic. Gaz. U. S. Pat. Office, **706**, 4: 780. 1956.

An ice cream mold consisting of several concentric tubes. Various flavors are filled into the spaces between the tubes. R. Whitaker

MILK AND CREAM

497. Valving spout having a foaming orifice. J. W. SOFFER and D. M. KITTERMAN (assignors to Development Research, Inc.) U. S. Patent 2,750,230. 5 claims. June 12, 1956. Offic. Gaz. U. S. Pat. Office, **707**, 2: 495. 1956.

A valve is described for releasing whipped cream and other foams from a pressure packed can. The flow of product is controlled by tilting the outlet spout with the finger.
R. Whitaker

NUTRITIVE VALUE OF DAIRY PRODUCTS

498. Orotic acid as a survival factor in rats deficient in the animal protein factors of casein. A. RABBI, M. MARCHETTI, R. VIVIANI, and G. MORUZZI. Nature, **177**, 4512: 757. 1956.

The authors present data which lead them to speculate that orotic acid may be one of the animal protein factors: a precursor, a part of the factors, or a substance with a high sparing action on the animal protein factors of casein.
R. Whitaker

499. The influence of breast feeding on weight gain in infants in the first year. J. MILLIS, Singapore. J. Pediat., **48**, 6: 770. 1956.

During the first year of life observations were made on 167 male and 156 female babies. They were divided into three groups: A—poor Indian; B—poor Chinese; C—wealthier Chinese. Each group was further divided as follows: 1—not breast fed, or weaned before 12 wk.; 2—weaned between 12 and 24 wk.; 3—weaned between 24 and 48 wk.; 4—partly or wholly breast fed for 48 wk. or more. In the C group, breast feeding made no difference to the weight gain at 24 wk. And at 1 yr. the breast-fed males had gained less than those "artificially" fed. In groups A and B significantly greater gain was observed at 24 wk. in the breast-fed babies; but there was no difference at the end of the yr. The fact that "artificial" feedings equalled breast milk feeding in group C and not in A and B is attributed to better weaning diets in C and a higher standard of hygiene.
F. E. Rice

500. Current practices in bread enrichment. K. KULP *et al.*, Am. Inst. of Baking, Chicago, Ill. J. Am. Dietet. Assoc., 32, 4: 331. 1956.

From 52 U. S. cities, 255 samples of enriched bread were collected and analyzed. More nonfat dry milk solids are now used in enriched bread than prior to World War II. In this survey 7.5% of the samples contained more than 3.5% milk solids; 75.1% were between 2.0 and 3.5%; 16.2% ranged between 1.0 and 2.0%; 1.2% contained less than 1.0%. It is estimated that bakers are now using an average of 3.9 lb. nonfat dry milk solids for each 100 lb. flour for making enriched bread. The report gives data also on added vitamins. iron and calcium.
F. E. Rice

501. Iron deficiency tested with radioactive foods. J. SCHULZ, Univ. of Calif. (L. A.) Med. Center, Los Angeles. Reported in Scope Weekly (Upjohn Co.), Apr. 25, 1956. p. 12.

Cows and hens injected with radioactive iron produce milk and eggs containing trace amounts of activity. Fed to infants, iron absorption can be traced through iron radioactivity. One of the objectives of the study was to determine whether infant diets should be supplemented with iron. F. E. Rice

502. Statistical report on incidence and duration of breast feeding in relation to personal-social and hospital maternity factors. E. JACKSON *et al.*, Yale School of Med., New Haven, Conn. Pediatrics, 17, 5: 700. 1956.

From 1942 through 1951 the incidence of breast feeding at the New Haven Hospital declined sharply from 81.9% in 1942 to 48.9% in 1946 and remained about that level through 1951. The percentage of babies discharged from the hospital on breast was 70.0 in 1942 and 44.7 in 1951. Duration of breast feeding was greater with mothers that were (a) older, (b) better educated, (c) Negro, (d) "rooming-in" (mother and baby in the same room) at the hospital. F. E. Rice

503. Nutritional requirements in early life. Borden Award address. L. E. HOLT. N. Y. Univ. Coll. of Med. Pediatrics, 17, 4: 578. 1956.

It is unnecessary to give nicotinic acid supplements to milk-fed infants. Tryptophane from the milk proteins is converted to this vitamin. The administration of nicotinic acid is even open to objection as it is in large part methylated before excretion and may thereby impose a load on the methylating mechanisms. In infant feeding it is unnecessary to fortify the milk intake with lysine. Lysine reinforced milk, such as has been marketed, was based on earlier determinations of the lysine requirements of babies, which have since been found to be too high. F. E. Rice

504. Amino acid imbalance and supplementation. Editorial. J. Am. Med. Assoc., **161**, 9: 884. 1956.

The work of Albanese and co-workers and of Holt and co-workers is reviewed, in relation to the question of whether cow's milk is deficient in lysine as used in infant feeding. It is concluded that the Holt evidence is more acceptable —that is, that the infant feeding formula is adequate with respect to this amino acid. Furthermore—"the addition of single amino acids (for instance lysine to cow's milk formulas) may well create a harmful amino acid balance." F. E. Rice

505. Lysine requirement of normal infant. S. E. SNYDERMAN, L. E. HOLT, P. NORTON, D. I. FOWLER, and E. HASSELMEYER, N. Y. Univ. Coll. of Med. Federation Proc., **15**, 1: 573. 1956. (Abstract of a paper presented before the Am. Inst. of Nutr., March 1956).

The lysine requirement was determined for 6 normal male infants 1 to 5 mo. of age. In all infants the requirement was less than 90 mg. per kg. per d. Commonly used cow's milk formulas provide a baby with more than 3 times this amount. A comparison of the minimal requirements of infants for lysine and tryptophane indicates an L/T ratio of 3.0. (Abstractor's note: This finding indicates that the cow's milk ratio is favorable and adequate, contrary to the published conclusion of Albanese *et al.*, J. Clin. Nutr., **4**, 2: 161. 1956). F. E. Rice

506. Lysine and tryptophane content of proteins and their utilization for human growth. A. A. ALBANESE, R. A. HIGGONS, G. M. HYDE, and L. ORTO. Am. J. Clin. Nutrition, **4**, 2: 161. 1956.

The ratio of tryptophane to lysine in proteins is proposed as of special importance. It is suggested that in feeding babies this ratio should be of the order of 6-7:1, which is about the ratio found in muscle protein (beef). In some feeding experiments with babies, beef muscle digest (5.9:1) and bovine plasma digest (6.9:1) were better utilized for growth than evaporated milk (4.3:1). The addition of 2-4% of lysine to evaporated milk, thus producing a ratio of about 6-8:1, resulted in protein utilization about equal to that observed with beef muscle and plasma digests. Lysine supplementation of wheat gluten increased its nutritional value up to that of milk proteins. F. E. Rice

507. Allergy in the infant and preschool child. B. RATNER, L. V. CRAWFORD, and J. G. FLYNN, N. Y. Med. Coll. Am. J. Diseases Children, **91**, 6: 593. 1956.

Under observation were 64 infants and children; 54 of them for more than a year, each one sensitive to one or more foods and/or inhalants. Onlly 28% (18 cases) were sensitive to milk. Fish, eggs, cereal grains, and members of the pea family produced reactions in more cases. Of the milk sensitive cases, only 4 were sensitive to casein; the others were sensitive to whey proteins, and could safely consume evaporated milk and other heat-treated milks in which the whey proteins are denatured.

In the few casein-sensitive cases soy bean preparations were substituted for milk. All children showing sensitivity to milk were sensitive also to other allergens. The reason milk is found to be a less prominent sensitizer now than formerly, is attributed to the preponderant number of infants that are today being fed on formulas prepared from evaporated milk and other "heat-denatured milks." F. E. Rice

508. Publicity about "a reducing diet." V. P. DOLE, Rockefeller Institute. Correspondence Dept., J. Am. Med. Assoc., **161**, 9: 901.

The reducing diets reported by Roy de Groot in Look Magazine, issues of June 12 and 26, 1956, mention Rockefeller Institute as the source. Two types of diets are published, one which has a rather wide choice of foods but low in protein, and the other, which is called a "crash diet" and which is to be used for a short time for fast reducing. The former includes no milk and little mention of other dairy products except butter. The latter "diet" is a mixture consisting of 1¼ cups of evaporated milk, 2 tbsp. vegetable oil, 6 tbsp. dextrose, and 1 cup of water. The total (20 oz.) is to be the only food consumed each day. In the letter to J. Am. Med. Assoc. Dr. Dole states that "the designation 'The Rockefeller Diet' is inaccurate, for the low protein diet is only one of many diets that have been studied at the Rockefeller Institute." He cautions against the use of any such low protein diet unless under a physician's care.

F. E. Rice

509. Discover cause of galactosemia. Report from N.I.H. J. Am. Dietet. Assoc., **32**, 5: 480. 1956.

Galactosemia has been found to be due to a deficiency of P-Gal. transferase in the blood of infants so afflicted. This metabolic defect is inherited; galactose is not utilized. Unless milk is removed from the diet of such infants, serious irreversible changes occur. Progressive symptoms are diarrhea, loss in weight, jaundice, cirrhosis of the liver, mental retardation, blindness due to cataract, death. F. E. Rice

PHYSIOLOGY AND ENDOCRINOLOGY

510. Effects of climate on body temperature and respiration rate of Buffaloes and Friesian cattle. K. A. Alim and I. A. Ahmed. Nature, 177, 4515: 900. 1956.

Weather conditions had a significant effect on body temperature (bt) and respiration rate (rr) of Buffaloes (B) and Friesian (F) cows and calves. The mean bt and rr of B was lower than F. The average bt of B was not significantly related to air temperature, whereas rr and air temperature were related. Correlation between bt and rr was statistically significant.

R. Whitaker

SANITATION AND CLEANSING

511. Cleaned-in-place pipeline milking systems for the dairy farm. H. P. Stephan, Universal Milking Mach. Co., Waukesha, Wis. S. Dairy Prod. J., **58**, 6: 50. 1955.

Five years of experiments at the University of Illinois with cleaning a 200-ft. milking machine pipeline in place have proved that top quality milk can be produced without ever taking such pipelines down. Success of C-I-P systems depends upon proper installation of lines and sound cleaning practices.

Essentials in installation are firm supports, flush interior joints, constant one inch drop in 10 ft. toward milk house, minimum number of ells and risers, drains at risers, fly and dust protectors for pipe openings, and moisture trap with automatic shut-off on vacuum line from the releaser, receiver, or cooler. One of three systems of cleaning may be used: pump pressure recirculation, vacuum recirculation or vacuum and gravity using milk lines without extra lines for return. Rubber parts and claws may be included.

In the pressure system the pipes must be kept full during cleaning and a velocity of 5 ft/sec maintained. In each system the pipes should be flushed with 100° F. water until it is discharged clear, cleaned by the recirculation of 160° F. water containing suitable alkaline or acid cleaners for 20 minutes, and thoroughly rinsed. The system should be sanitized with a sodium hypochlorite solution containing 200 ppm. av. Cl. immediately before use. Complete drainage before the milk enters is important.

F. W. Bennett

512. Can washing system. R. E. Farison (assignor to The Diversey Corp.). U. S. Patent 2,746,465. 14 claims. May 22, 1956. Offic. Gaz. U. S. Pat. Office, **706**, 4: 795. 1956.

An arrangement is described for intermittently circulating a cleaning solution from a sump beneath inverted cans through a jet. Provision is made also for automatically feeding a stock solution of cleaning compound into the system as the solution is used.

R. Whitaker

513. Combination settling, flow division and weir tank for waste disposal systems. H. A. Trebler and J. P. Horton (assignors to National Dairy Research Laboratories, Inc.). U. S. Patent 2,749,302. 3 claims. June 5, 1956. Offic. Gaz. U. S. Pat. Office, **707**, 1: 240. 1956.

Construction details are given for a tank in which wastes from dairy plants may be sedimented to remove suspended solids.

R. Whitaker

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